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ENCYCLOPÆDIA BRITANNICA;
OR, A
D I C T I O N A R Y
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AND
MISCELLANEOUS LITERATURE;

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PHOTOGRAPHIC ARTS
MISCELLANEOUS LITERATURE

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THE PHOTOGRAPHIC ARTS

The history, theory, and practice of the
art, as it is now conducted, and its
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science and art.

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ENCYCLOPÆDIA BRITANNICA.

P L A

Plant.

PLANT is defined to be, an organical body, destitute of sense and spontaneous motion, adhering to another body in such a manner as to draw from it its nourishment, and having a power of propagating itself by seeds.

The vegetation and economy of plants is one of those subjects in which our knowledge is extremely circumscribed. A total inattention to the structure and economy of plants is the chief reason of the small progress that has been made in the principles of vegetation, and of the instability and fluctuation of our theories concerning it; for which reason we shall give a short description of the structure of plants, beginning with the seed, and tracing its progress and evolution to a state of maturity.

1. *Of Seeds.*] The seeds of plants are of various figures and sizes. Most of them are divided into two lobes; though some, as those of the cress-kind, have six; and others, as the grains of corn, are not divided, but entire.

But as the essential properties of all seeds are the same, when considered with regard to the principles of vegetation, our particular descriptions shall be limited to one seed, viz. the great garden-bean. Neither is the choice of this seed altogether arbitrary; for, after it begins to vegetate, its parts are more conspicuous than many others, and consequently better calculated for investigation.

This seed is covered with two coats or membranes. The outer coat is extremely thin, and full of pores; but may be easily separated from the inner one (which is much thicker), after the bean has been boiled, or lain a few days in the soil. At the thick end of the bean there is a small hole visible to the naked eye, immediately over the radicle or future root, that it may have a free passage into the soil (fig. 1. A). When these coats are taken off, the body of the seed appears, which is divided into two smooth portions or lobes. The smoothness of the lobes is owing to a thin film or cuticle with which they are covered.

At the basis of the bean is placed the radicle or future root (fig. 3. A). The trunk of the radicle, just as it enters into the body of the seed, divides into two capital branches, one of which is inserted into each lobe, and sends off smaller ones in all directions through the whole substance of the lobes (fig. 4. AA). These ramifications become so extremely minute towards the edges of the lobes, that they require the finest glasses

VOL. XV. Part I.

P L A

Plant.

to render them visible. To these ramifications Grew and Malpighi have given the name of *seminal root*; because, by means of it, the radicle and plume, before they are expanded, derive their principal nourishment.

The plume, bud, or germ (fig. 3.), is inclosed in two small corresponding cavities in each lobe. Its colour and consistence is much the same with those of the radicle, of which it is only a continuation, but having a quite contrary direction; for the radicle descends into the earth, and divides into a great number of smaller branches or filaments; but the plume ascends into the open air, and unfolds itself into all the beautiful variety of stem, branches, leaves, flowers, fruit, &c. The plume in corn shoots from the smaller end of the grain, and among maltsters goes by the name of *acrospire*.

The next thing to be taken notice of is the substance or parenchymatous part of the lobes. This is not a mere concremented juice, but is curiously organized, and consists of a vast number of small bladders resembling those in the pith of trees (fig. 4.)

Besides the coats, cuticle, and parenchymatous parts, there is a substance perfectly distinct from these, distributed in different proportions through the radicle, plume, and lobes. This inner substance appears very plainly in a transverse section of the radicle or plume. Towards the extremity of the radicle it is one entire trunk; but higher up it divides into three branches; the middle one runs directly up to the plume, and the other two pass into the lobes on each side, and spread out into a great variety of small branches through the whole body of the lobes (fig. 4.) This substance is very properly termed the *seminal root*: for when the seed is sown, the moisture is first absorbed by the outer coats, which are everywhere furnished with sap and air-vessels; from these it is conveyed to the cuticle; from the cuticle it proceeds to the pulpy part of the lobes; when it has got thus far, it is taken up by the mouths of the small branches of the seminal root, and passes from one branch into another, till it is all collected into the main trunk, which communicates both with the plume and radicle, the two principle involved organs of the future plant. After this the sap or vegetable food runs in two opposite directions: part of it ascends into the plume, and promotes the growth and expansion of that organ; and part of it descends into the radicle, for nourishing and evolving the root and its various filaments. Thus the plume and radicle continue their progress in opposite directions till the plant arrives at maturity.

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Plant.

It is here worth remarking, that every plant is really possessed of two roots, both of which are contained in the seed. The plume and radicle, when the seed is first deposited in the earth, derive their nourishment from the feminal root; but, afterwards, when the radicle begins to shoot out its filaments, and to absorb some moisture, not, however, in a sufficient quantity to supply the exigencies of the plume, the two lobes, or main body of the seed, rise along with the plume, assume the appearance of two leaves, resembling the lobes of the seed in size and shape, but having no resemblance to those of the plume, for which reason they have got the name of *diffimilar leaves*.

These dissimilar leaves defend the young plume from the injuries of the weather, and at the same time, by absorbing dew, air, &c. assist the tender radicle in nourishing the plume, with which they have still a connection by means of the feminal root above described. But when the radicle or second root has descended deep enough into the earth, and has acquired a sufficient number of filaments or branches for absorbing as much aliment as is proper for the growth of the plume; then the feminal or dissimilar leaves, their utility being entirely superseded, begin to decay and fall off.

Plate
CCCXCIV

Fig. 1. A, the foramen or hole in the bean through which the radicle shoots into the soil.

Fig. 2. A transverse section of the bean; the dots being the branches of the feminal root.

Fig. 3. A, the radicle. B, the plume or bud.

Fig. 4. A, a longitudinal section of one of the lobes of the bean a little magnified, to show the small bladders of which the pulpy or parenchymatous part is composed.

Figs. 5. 6. A, a transverse section of the radicle. B, a transverse section of the plume, showing the organs or vessels of the feminal root.

Plate
CCCXCI.

Fig. 4. A view of the feminal root branched out upon the lobes.

Plate
CCCXCIV

Fig. 7. The appearance of the radicle, plume, and feminal root, when a little further advanced in growth.

Having thus briefly described the seed, and traced its evolution into three principal organic parts, viz. the plume, radicle, and feminal leaves, we shall next take an anatomical view of the root, trunk, leaves, &c.

2. *Of the root.*] In examining the root of plants, the first thing that presents itself is the skin, which is of various colours in different plants. Every root, after it has arrived at a certain age, has a double skin. The first is coeval with the other parts, and exists in the seed: but afterwards there is a ring sent off from the bark, and forms a second skin; e. g. in the root of the dandelion, towards the end of May, the original or outer skin appears shrivelled, and is easily separated from the new one, which is fresher, and adheres more firmly to the bark. Perennial plants are supplied in this manner with a new skin every year; the outer one always falls off in the autumn and winter, and a new one is formed from the bark in the succeeding spring. The skin has numerous cells or vessels, and is a continuation of the parenchymatous part of the radicle. However, it does not consist solely of parenchyma; for the microscope shows that there are many tubular ligneous vessels interspersed through it.

When the skin is removed, the true cortical substance or bark appears, which is also a continuation of the pa-

Plant.

renchymatous part of the radicle, but greatly augmented. The bark is of very different sizes. In most trees it is exceeding thin in proportion to the wood and pith. On the other hand, in carrots, it is almost one-half of the semidiameter of the root; and, in dandelion, it is nearly twice as thick as the woody part.

The bark is composed of two substances; the parenchyma or pulp, which is the principal part, and a few woody fibres. The parenchyma is exceedingly porous, and has a great resemblance to a sponge; for it shrivels considerably when dried, and dilates to its former dimensions when infused in water. These pores or vessels are not pervious, so as to communicate with each other; but consist of distinct little cells or bladders, scarcely visible without the assistance of the microscope. In all roots, these cells are constantly filled with a thin watery liquor. They are generally of a spherical figure; though in some roots, as the bugloss and dandelion, they are oblong. In many roots, as the horse-radish, peony, asparagus, potatoe, &c. the parenchyma is of one uniform structure. But in others it is more diversified, and puts on the shape of rays, running from the centre towards the circumference of the bark. These rays sometimes run quite through the bark, as in lovage; and sometimes advance towards the middle of it, as in melilot and most of the leguminous and umbelliferous plants. These rays generally stand at an equal distance from each other in the same plant; but the distance varies greatly in different plants. Neither are they of equal sizes: in carrot they are exceedingly small, and scarcely discernible; in melilot and chervil, they are thicker. They are likewise more numerous in some plants than in others. Sometimes they are of the same thickness from one edge of the bark to the other; and some grow wider as they approach towards the skin. The vessels with which these rays are amply furnished, are supposed to be air-vessels, because they are always found to be dry, and not so transparent as the vessels which evidently contain the sap.

In all roots there are ligneous vessels dispersed in different proportions through the parenchyma of the bark. These ligneous vessels run longitudinally through the bark in the form of small threads, which are tubular, as is evident from the rising of the sap in them when a root is cut transversely. These ligneous sap-vessels do not run in direct lines through the bark, but at small distances incline towards one another, in such a manner that they appear to the naked eye to be inosculated; but the microscope discovers them to be only contiguous, and braced together by the parenchyma. These braces or coarctations are very various both in size and number in different roots; but in all plants they are most numerous towards the inner edge of the bark. Neither are these vessels single tubes; but, like the nerves in animals, are bundles of 20 or 30 small contiguous cylindrical tubes, which uniformly run from the extremity of the root, without sending off any branches or suffering any change in their size or shape.

In some roots, as parsnep, especially in the ring next the inner extremity of the bark, these vessels contain a kind of lymph, which is sweeter than the sap contained in the bladders of the parenchyma. From this circumstance they have got the name of *lymph-duets*.

These lymph-duets sometimes yield a mucilaginous lymph, as in the comphrey; and sometimes a white

milky

Plant.

milky glutinous lymph, as in the angelica, fonchus, burdock, scorzonera, dandelion, &c. The lymph-ducts are supposed to be the vessels from which the gums and balsams are secreted. The lymph of fennel, when exposed to the air, turns into a clear transparent balsam; and that of the scorzonera, dandelion, &c. condenses into a gum.

The situation of the vessels is various. In some plants they stand in a ring or circle at the inner edge of the bark, as in asparagus; in others, they appear in lines or rays, as in borage; in the parsnep, and several other plants, they are most conspicuous towards the outer edge of the bark; and in the dandelion, they are disposed in the form of concentric circles.

The wood of roots is that part which appears after the bark is taken off, and is firmer and less porous than the bark or pith. It consists of two distinct substances, viz. the pulpy or parenchymatous, and the ligneous. The wood is connected to the bark by large portions of the bark inserted into it. These insertions are mostly in the form of rays, tending to the centre of the pith, which are easily discernible by the eye in a transverse section of most roots. These insertions, like the bark, consist of many vessels, mostly of a round or oval figure.

The ligneous vessels are generally disposed in collateral rows running longitudinally through the root. Some of these contain air, and others sap. The *air-vessels* are so called, because they contain no liquor. These air-vessels are distinguished by being whiter than the others.

The pith is the central part of the root. Some roots have no pith, as the stramonium, nicotiana, &c.; others have little or none at the extremities of the roots, but have a considerable quantity of it near the top. The pith, like every other part of a plant, is derived from the seed; but in some it is more immediately derived from the bark: for the insertions of the bark running in betwixt the rays of the wood, meet in the centre, and constitute the pith. It is owing to this circumstance, that, among roots which have no pith in their lower parts, they are amply provided with it towards the top, as in columbine, lovage, &c.

The bladders of the pith are of very different sizes, and generally of a circular figure. Their position is more uniform than in the bark. Their sides are not mere films, but a composition of small fibres or threads; which gives the pith, when viewed with a microscope, the appearance of a piece of fine gauze or net-work.

We shall conclude the description of roots with observing, that their whole substance is nothing but a congeries of tubes and fibres, adapted by nature for the absorption of nourishment, and of course the extension and augmentation of their parts.

Plate
CCCXCIV Fig. 8. A transverse section of the root of worm-

wood as it appears to the naked eye.
Fig. 9. A section of fig. 8. magnified. AA, the skin, with its vessels. BBBB, the bark. The round holes CCC, &c. are the lymph-ducts of the bark: All the other holes are little cells and sap-vessels. DDD, parenchymatous insertions from the bark, with the cells, &c. EEEE, the rays of the wood, in which the holes are the air-vessels. N. B. This root has no pith.

3. *Of the Trunk, Stalk, or Stem.*] In describing the trunks of plants, it is necessary to premise, that whatever is said with regard to them applies equally to the branches.

Plant.

The trunk, like the root, consists of three parts, viz. the bark, wood, and pith. These parts, though substantially the same in the trunk as in the root, are in many cases very different in their texture and appearance.

The skin of the bark is composed of very minute bladders, interspersed with longitudinal woody fibres, as in the nettle, thistle, and most herbs. The outside of the skin is visibly porous in some plants, particularly the cane.

The principal body of the bark is composed of pulp or parenchyma, and innumerable vessels much larger than those of the skin. The texture of the pulpy part, though the same substance with the parenchyma in roots, yet seldom appears in the form of rays running towards the pith; and when these rays do appear, they do not extend above half way to the circumference. The vessels of the bark are very differently situated, and destined for various purposes in different plants. For example, in the bark of the pine, the inmost are lymph ducts, and exceedingly small; the outmost are gum or resiniferous vessels, destined for the secretion of turpentine; and are so large as to be distinctly visible to the naked eye.

The wood lies between the bark and pith, and consists of two parts, viz. a parenchymatous and ligneous. In all trees, the parenchymatous part of the wood, though much diversified as to size and consistence, is uniformly disposed in diametrical rays, or insertions running betwixt similar rays of the ligneous part.

The true wood is nothing but a congeries of old dried lymph-ducts. Between the bark and the wood a new ring of these ducts is formed every year, which gradually loses its softness as the cold season approaches, and towards the middle of winter is condensed into a solid ring of wood. These annual rings, which are distinctly visible in most trees when cut through, serve as natural marks to distinguish their age (fig. 10. 11.) The rings of one year are sometimes larger, sometimes less, than those of another, probably owing to the favourableness or unfavourableness of the season. Plate
CCCXCIV

The pith, though of a different texture, is exactly of the same substance with the parenchyma of the bark, and the insertions of the wood. The quantity of pith is various in different plants. Instead of being increased every year like the wood, it is annually diminished, its vessels drying up, and assuming the appearance and structure of wood; inasmuch that in old trees there is scarce such a thing as pith to be discerned.

A ring of sap-vessels are usually placed at the outer edge of the pith, next the wood. In the pine, fig, and walnut, they are very large. The parenchyma of the pith is composed of small cells or bladders, of the same kind with those of the bark, only of a larger size. The general figure of these bladders is circular; though in some plants, as the thistle and borage, they are angular. Though the pith is originally one connected chain of bladders, yet as the plant grows old they shrink, and open in different directions. In the walnut, after a certain age, it appears in the form of a regular transverse hollow division. In some plants it is altogether wanting; in others, as the fonchus, nettle, &c. there is only a transverse partition of it at every joint. Many other varieties might be mentioned; but these must be left to the observation of the reader.

Plant.
Plate
CCCXCIV

Fig. 10. A transverse section of a branch of ash, as it appears to the eye.

Fig. 11. The same section magnified. AA, the bark. BBB, an arched ring of sap-vessels next the skin. CCC, the parenchyma of the bark with its cells, and another arched ring of sap-vessels. DD, a circular line of lymph-ducts immediately below the above arched ring. EE, the wood. F, the first year's growth. G, the second. H, the third year's growth. III, the true wood. KK, the great air-vessels. LL, the lesser ones. MMM, the parenchymatous insertions of the bark represented by the white rays. NO, the pith, with its bladders or cells.

4. *Of the Leaves.*] The leaves of plants consist of the same substance with that of the trunk. They are full of nerves or woody portions, running in all directions, and branching out into innumerable small threads, interwoven with the parenchyma like fine lace or gauze.

The skin of the leaf, like that of an animal, is full of pores, which both serve for perspiration and for the absorption of dews, air, &c. These pores or orifices differ both in shape and magnitude in different plants, which is the cause of that variety of texture or grain peculiar to every plant.

The pulpy or parenchymatous part consists of very minute fibres, wound up into small cells or bladders. These cells are of various sizes in the same leaf.

All leaves, of whatever figure, have a marginal fibre, by which all the rest are bounded. The particular shape of this fibre determines the figure of the leaf.

The vessels of leaves have the appearance of inosculation; but, when examined by the microscope, they are found only to be interwoven or laid along each other.

What are called *air-vessels*, or those which carry no sap, are visible even to the naked eye in some leaves. When a leaf is slowly broke, they appear like small woolly fibres, connected to both ends of the broken piece.

Plate
CCCXCV

Fig. 14. The appearance of the air-vessels to the eye, in a vine-leaf drawn gently asunder.

Fig. 15. A small piece cut off that leaf.

Fig. 16. The same piece magnified, in which the vessels have the appearance of a screw.

Fig. 17. The appearance of these vessels as they exist in the leaf before they are stretched out.

5. *Of the Flower.*] It is needless here to mention any thing of the texture, or of the vessels, &c. of flowers, as they are pretty similar to those of the leaf. It would be foreign to our present purpose to take any notice of the characters and distinctions of flowers. These belong to the science of BOTANY, to which the reader is referred.

There is one curious fact, however, which must not be omitted, viz. That every flower is perfectly formed in its parts many months before it appears outwardly; that is, the flowers which appear this year are not properly speaking the flowers of this year, but of the last. For example, mezereon generally flowers in January; but these flowers were completely formed in the month of August preceding. Of this fact any one may satisfy himself by separating the coats of a tulip-root about the beginning of September; and he will find that the two innermost form a kind of cell, in the centre of which

stands the young flower, which is not to make its appearance till the following April or May. Fig. 18. exhibits a view of the tulip-root when dissected in September, with the young flower towards the bottom.

6. *Of the Fruit.*] In describing the structure of fruits, a few examples shall be taken from such as are most generally known.

A *pear*, besides the skin, which is a production of the skin of the bark, consists of a double parenchyma or pulp, sap, and air-vessels, calculary and acetary.

The outer parenchyma is the same substance continued from the bark, only its bladders are larger and more succulent.

It is everywhere interspersed with small globules or grains, and the bladders respect these grains as a kind of centres, every grain being the centre of a number of bladders. The sap and air-vessels in this pulp are extremely small.

Next the core is the inner pulp or parenchyma, which consists of bladders of the same kind with the outer, only larger and more oblong, corresponding to those of the pulp, from which it seems to be derived. This inner pulp is much sourer than the other, and has none of the small grains interspersed through it; and hence it has got the name of *acetary*.

Between the acetary and outer pulp, the globules or grains begin to grow larger, and gradually unite into a hard stony body, especially towards the corculum or stool of the fruit; and from this circumstance it has been called the *calculary*.

These grains are not derived from any of the organic parts of the tree; but seem rather to be a kind of concretions precipitated from the sap, similar to the precipitation from wine, urine, and other liquors.

The core is a roundish cavity in the centre of the pear, lined with a hard woody membrane, in which the seed is inclosed. At the bottom of the core there is a small duct or canal, which runs up to the top of the pear; this canal allows the air to get into the core, for the purpose of drying and ripening the seeds.

Fig. 19. a transverse section of a pear, as it appears to the naked eye. A, the skin, and a ring of sap-vessels. B, the outer parenchyma, or pulp, with its vessels, and ligneous fibres interspersed. C, the inner parenchyma, or acetary, with its vessels, which are larger than the outer one. D, the core and seeds.

Fig. 20. a piece cut off fig. 19.

Fig. 21. is fig. 20. magnified. A A A, the small grains or globules, with the vessels radiated from them.

Fig. 22. a longitudinal section of the pear, showing a different view of the same parts with those of fig. 19. A the channel, or duct, which runs on the top of the pear to the bottom of the core.

In a *lemon*, the parenchyma appears in three different forms. The parenchyma of the rind is of a coarse texture, being composed of thick fibres, woven into large bladders. Those nearest the surface contain the essential oil of the fruit, which bursts into a flame when the skin is squeezed over a candle. From this outmost parenchyma nine or ten insertions or lamellæ are produced, which run between as many portions of the pulp, and unite into one body in the centre of the fruit, which corresponds to the pith in trunks or roots. At the bottom and top of the lemon, this pith evidently joins with the rind, without the intervention of any lamellæ. This circumstance

Plant.

Plate
CCCXCVI

Plant.

Plant.

circumstance shows, that the pith and bark are actually connected in the trunk and roots of plants, though it is difficult to demonstrate the connection, on account of the closeness of their texture, and the minuteness of their fibres. Many vessels are dispersed through the whole of this parenchyma; but the largest ones stand on the inner edge of the rind, and the outer edge of the pith, just at the two extremities of each lamella.

The second kind of parenchyma is placed between the rind and the pith; is divided into distinct bodies by the lamellæ; and each of these bodies forms a large bag.

These bags contain a third parenchyma, which is a cluster of smaller bags, distinct and unconnected with each other, having a small stalk by which they are fixed to the large bag. Within each of these small bags are many hundreds of bladders, composed of extremely minute fibres. These bladders contain the acid juice of the lemon.

Plate
CCCXCV.

Fig. 12. a longitudinal section of a lemon. A A A, the rind with the vessels which contain the essential oil. B B, the substance corresponding to the pith, formed by the union of the lamellæ or infertions. C C, its continuation and connection with the rind, independent of the infertions.

Fig. 13. a transverse section of the lemon. B B B, &c. the nine pulpy bags, or second parenchyma, placed between the rind and the pith; and the cluster of small bags, which contain the acid juice, inclosed in the large ones. C C, the large vessels that surround the pith. D D, two of the large bags laid open, showing the seeds, and their connection with the lamellæ or membranes which form the large bags.

Of the Perspiration of PLANTS, and the quantity of moisture daily imbibed by them.—These curious particulars have been determined with great accuracy by Dr Hales. The method he took to accomplish his purpose was as follows.—In the month of July, commonly the warmest season of the year, he took a large sun-flower three feet and an half high, which had been purposely planted in a flower-pot when young. He covered the pot with thin milled lead, leaving only a small hole to preserve a communication with the external air, and another by which he might occasionally supply the plant with water. Into the former he inserted a glass tube nine inches long, and another shorter tube into the hole by which he poured in the water; and the latter was kept close stopped with a cork, except when there was occasion to use it. The holes in the bottom of the pot were also stopped up with corks, and all the crevices shut with cement.—Things being thus prepared, the pot and plant were weighed for 15 several days; after which the plant was cut off close to the leaden plate, and the stump well covered with cement. By weighing, he found that there perspired through the unglazed porous pot two ounces every 12 hours; which being allowed for in the daily weighing of the plant and pot, the greatest perspiration, in a warm day, was found to be one pound 14 ounces; the middle rate of perspiration, one pound four ounces; the perspiration of a dry warm night, without any sensible dew, was about three ounces; but when there was any sensible though small dew, the perspiration was nothing; and when there was a large dew, or some little rain in the night,

the plant and pot was increased in weight two or three ounces.

In order to know what quantity was perspired from a square inch of surface, our author cut off all the leaves of the plant, and laid them in five several parcels, according to their several sizes; and then measured the surface of a leaf of each parcel, by laying over it a large lattice made with threads, in which each of the little squares were $\frac{1}{4}$ of an inch; by numbering of which, he had the surface of the leaves in square inches; which, multiplied by the number of leaves in the corresponding parcels, gave the area of all the leaves. By this method he found the surface of the whole plant above ground to be 666 square inches, or 39 square feet. He dug up another sun-flower of nearly the same size, which had eight main roots, reaching 15 inches deep and sidewise, from the stem. It had besides a very thick bush of lateral roots from the eight main roots, extending every way in a hemisphere about nine inches from the stem and main roots. In order to estimate the length of all the roots, he took one of the main roots with its laterals, and measured and weighed them; and then weighed the other seven with their laterals; by which means he found the sum of all their lengths to be 1448 feet. Supposing then the periphery of these roots at a medium to be 0.131 of an inch, then their surface will be 2276 square inches, or 15.8 square feet; that is, equal to 0.4 of the surface of the plant above ground. From calculations drawn from these observations, it appears, that a square inch of the upper surface of this plant perspires $\frac{1}{257}$ part of an inch in a day and a night; and that a square inch of the surface underground imbibed $\frac{1}{27}$ of an inch in the same time.

The quantity perspired by different plants, however, is by no means equal. A vine-leaf perspires only $\frac{1}{257}$ of an inch in 12 hours; a cabbage perspires $\frac{1}{15}$ of an inch in the same time; an apple-tree $\frac{1}{100}$ in 12 hours; and a lemon $\frac{1}{148}$ in 12 hours.

Of the circulation of the Sap in PLANTS.—Concerning this there have been great disputes; some maintaining, that the vegetable sap has a circulation analogous to the blood of animals; while others affirm, that it only ascends in the day-time, and descends again in the night. In favour of the doctrine of circulation it has been urged, that upon making a transverse incision into the trunk of a tree, the juice which runs out proceeds in greater quantity from the upper than the lower part; and the swelling in the upper lip is also much greater than in the lower. It appears, however, that when two similar incisions are made, one near the top and the other near the root, the latter expends much more sap than the former. Hence it is concluded, that the juice ascends by one set of vessels and descends by another. But, in order to show this clearly, it would be necessary first to prove that there is in plants, as in animals, some kind of centre from which the circulation begins, and to which it returns; but no such centre has been discovered by any naturalist; neither is there the least provision apparently made by nature whereby the sap might be prevented from descending in the very same vessels through which it ascends. In the lacteal vessels of animals, which we may suppose to be analogous to the roots of vegetables, there are valves which effectually

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Plant. ly prevent the chyle when once absorbed from returning into the intestines; but no such thing is observed in the vessels of vegetables: whence it must be very probable, that when the propelling force ceases, the juice descends by the very same vessels through which it ascended. — This matter, however, has been cleared up almost as well as the nature of the subject will admit of by the experiments of Dr Hales ‡. These experiments are so numerous, that for a particular account of them we must refer to the work itself; however, his reasoning against the circulation of the sap will be sufficiently intelligible without them. “ We see (says he), in many of the foregoing experiments, what quantities of moisture trees daily imbibe and perspire: now the celerity of the sap must be very great, if that quantity of moisture must, most of it, ascend to the top of the tree, then descend, and ascend again, before it is carried off by perspiration.

‡ *Vegetable Statics*, vol. i. p. 142.

“ The defect of a circulation in vegetables seems in some measure to be supplied by the much greater quantity of liquor, which the vegetable takes in, than the animal, whereby its motion is accelerated; for we find the sun-flower, bulk for bulk, imbibes and perspires 17 times more fresh liquor than a man, every 24 hours.

“ Besides, Nature’s great aim in vegetables being only that the vegetable life be carried on and maintained, there was no occasion to give its sap the rapid motion which was necessary for the blood of animals.

“ In animals, it is the heart which sets the blood in motion, and makes it continually circulate; but in vegetables we can discover no other cause of the sap’s motion but the strong attraction of the capillary sap-vessels, assisted by the brisk undulations and vibrations caused by the sun’s warmth, whereby the sap is carried up to the top of the tallest trees, and is there perspired off through the leaves: but when the surface of the tree is greatly diminished by the loss of its leaves, then also the perspiration and motion of the sap is proportionably diminished, as is plain from many of the foregoing experiments: so that the ascending velocity of the sap is principally accelerated by the plentiful perspiration of the leaves, thereby making room for the fine capillary vessels to exert their vastly attracting power, which perspiration is effected by the brisk rarefying vibrations of warmth; a power that does not seem to be any ways well adapted to make the sap descend from the tops of vegetables by different vessels to the root.

“ If the sap circulated, it must needs have been seen descending from the upper part of large gashes cut in branches set in water, and with columns of water pressing on their bottoms in long glass tubes. In both which cases, it is certain that great quantities of water passed through the stem, so that it must needs have been seen descending, if the return of the sap downwards were by trusion or pulsion, whereby the blood in animals is returned through the veins to the heart; and that pulsion, if there were any, must necessarily be exerted with prodigious force, to be able to drive the sap through the finer capillaries. So that, if there be a return of the sap downwards, it must be by attraction, and that a very powerful one, as we may see by many of these experiments. But it is hard to conceive what and where that power is which can be equivalent to that provision nature has made for the as-

Plant. cent of the sap in consequence of the great perspiration of the leaves.

“ The instances of the jessamine-tree, and of the passion-tree, have been looked upon as strong proofs of the circulation of the sap, because their branches, which were far below the inoculated bud, were gilded: but we have many visible proofs in the vine, and other bleeding trees, of the sap’s receding back, and pushing forwards alternately, at different times of the day and night. And there is great reason to think that the sap of all other trees has such an alternate, receding, and progressive motion, occasioned by the alternacies of day and night, warm and cool, moist and dry.

“ For the sap in all vegetables does probably recede in some measure from the tops of the branches, as the sun leaves them; because its rarefying power then ceasing, the greatly rarefied sap, and air mixed with it, will condense, and take up less room than they did, and the dew and rain will then be strongly imbibed by the leaves; whereby the body and branches of the vegetable which have been much exhausted by the great evaporation of the day, may at night imbibe sap and dew from the leaves; for by several experiments, plants were found to increase considerably in weight, in dewy and moist nights. And by other experiments on the vine, it was found that the trunk and branches of vines were always in an imbibing state, caused by the great perspiration of the leaves, except in the bleeding season; but when at night that perspiring power ceases, then the contrary imbibing power will prevail, and draw the sap and dew from the leaves, as well as moisture from the roots.

“ And we have a farther proof of this by fixing mercurial gages to the stems of several trees which do not bleed, whereby it is found that they are always in a strongly imbibing state, by drawing up the mercury several inches: whence it is easy to conceive, how some of the particles of the gilded bud in the inoculated jessamine may be absorbed by it, and thereby communicate their gilding miasma to the sap of other branches; especially when, some months after the inoculation, the stock of the inoculated jessamine is cut off a little above the bud; whereby the stock, which was the counteracting part to the stem, being taken away, the stem attracts more vigorously from the bud.

“ Another argument for the circulation of the sap is, that some sorts of the grafts will infect and canker the stocks they are grafted on: but by mercurial gages fixed to fresh-cut stems of trees, it is evident that those stems were in a strongly imbibing state; and consequently the cankered stocks might very likely draw sap from the graft, as well as the graft alternately from the stock; just in the same manner as leaves and branches do from each other, in the vicissitudes of day and night. And this imbibing power of the stock is so great, where only some of the branches of a tree are grafted, that the remaining branches of the stock will, by their strong attraction, starve those grafts; for which reason it is usual to cut off the greatest part of the branches of the stock, leaving only a few small ones to draw up the sap.

“ The instance of the ilex grafted upon the English oak, seems to afford a very considerable argument against a circulation. For, if there were a free uniform

Fig. 1.
Garden Bean



Fig. 2.



Fig. 3.



Fig. 4.
Slice of a Bean

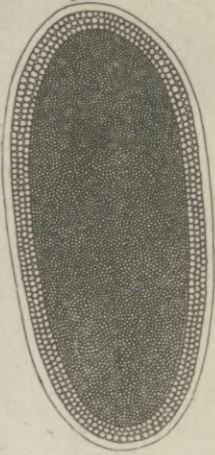


Fig. 7.

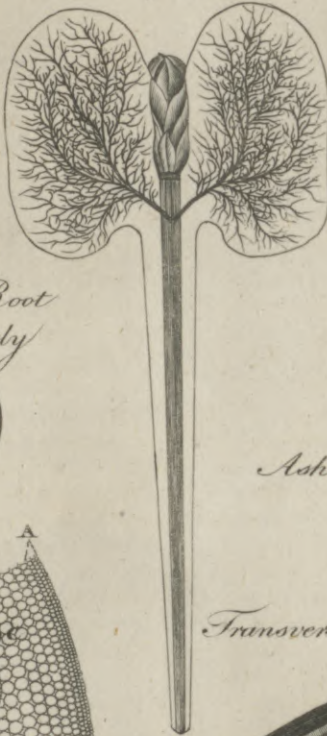


Fig. 5.
Radical



Fig. 6.
Plume



Fig. 8.
Wormwood Root
cut transversely



Fig. 10.

Ash Branch cut transversely



Fig. 9.
Section of Fig. 8. Magnified

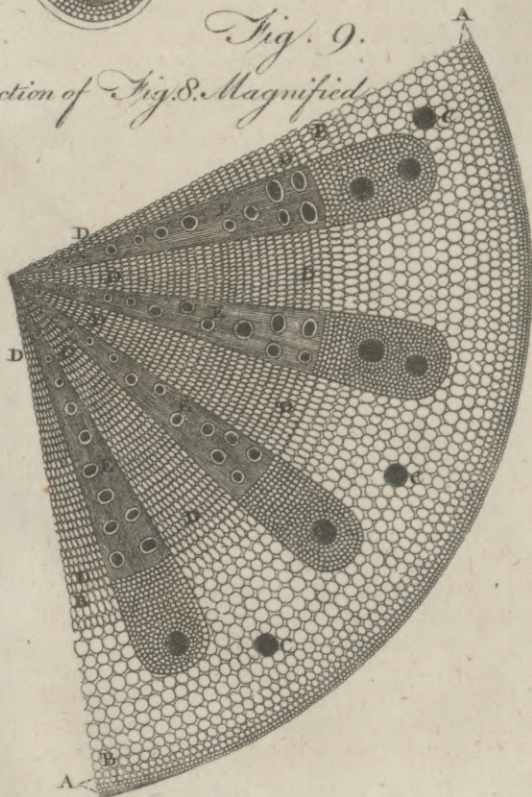


Fig. 11.

Transverse Section of the Ash Branch Magnified

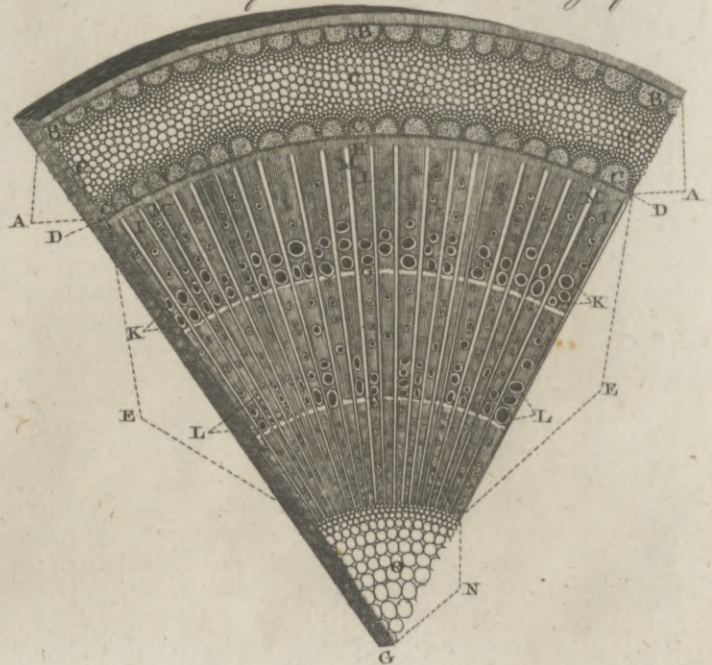


Fig. 12.

A Lemon cut down.

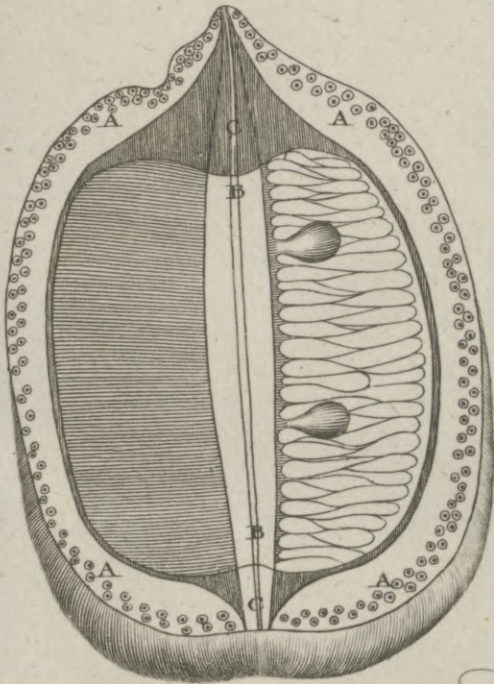


Fig. 13.

Lemon cut Transversely.

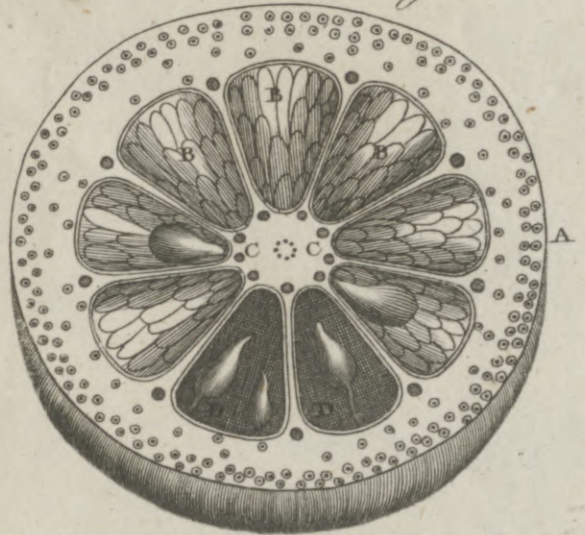


Fig. 16.

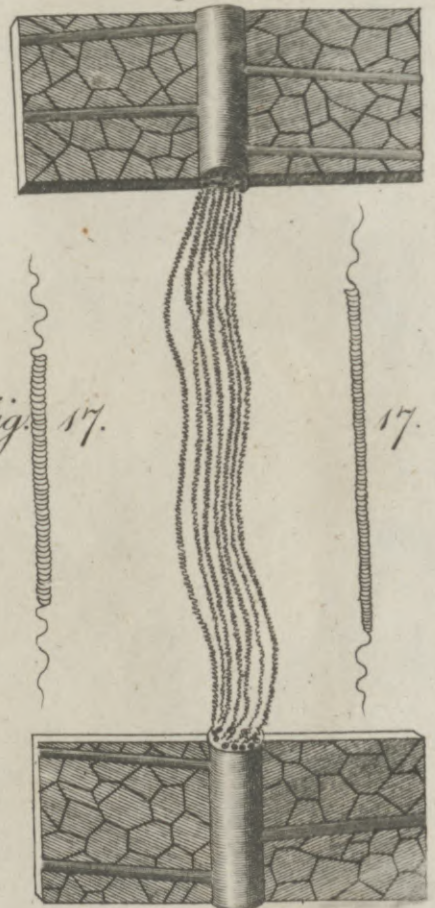


Fig. 14.

Vine Leaf.



Fig. 15.

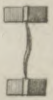


Fig. 18.

Tulip Root.



Fig. 17.

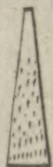
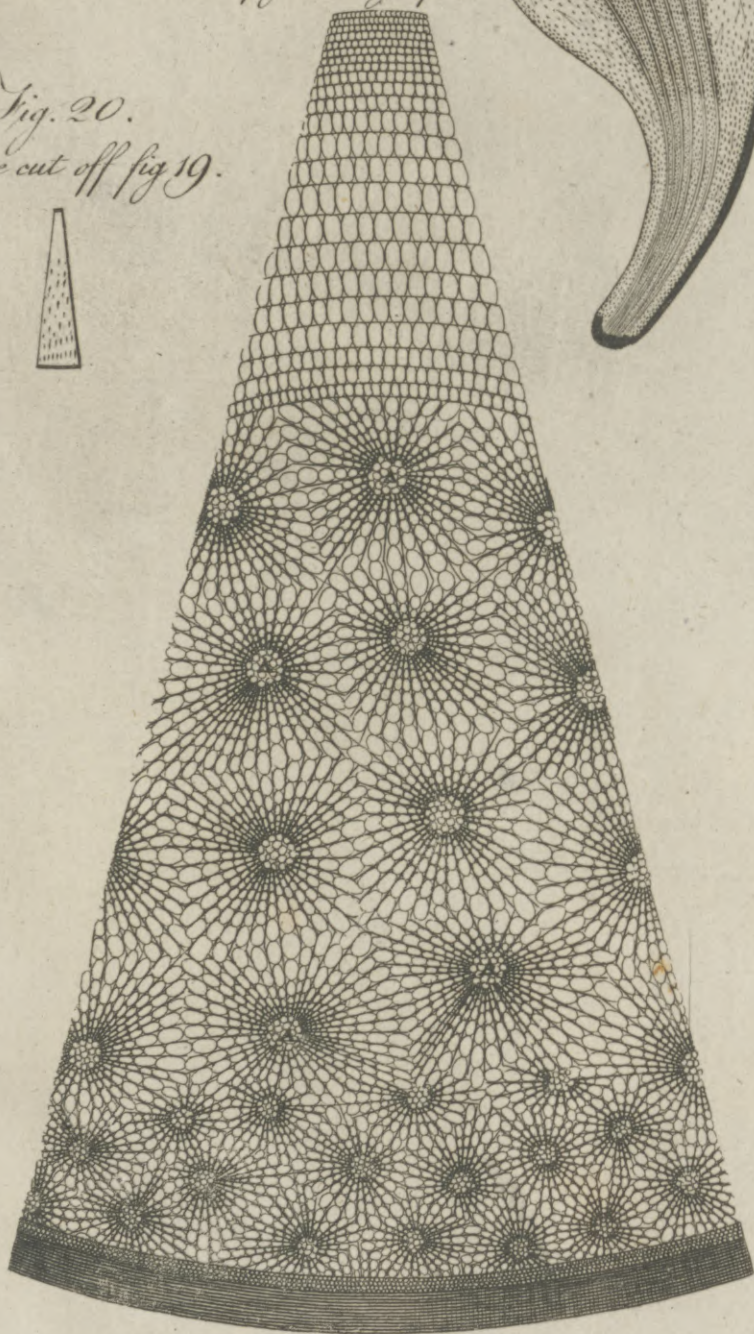
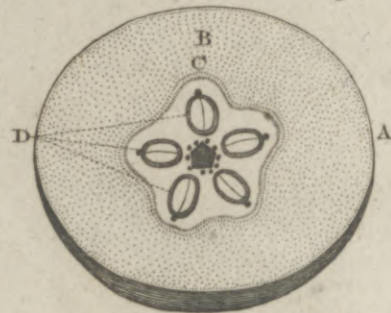
17.

Anatomy of PLANTS.
 Fig. 22.
 Pear cut Longitudinally.

Plate CCCXCVI.
 Fig. 19.
 Pear cut Transversely.

Fig. 21.
 fig 20 magnified.

Fig. 20.
 piece cut off fig 19.



Patagonian Penguin.



A. Bell Pinx. W. A. Sculptor fecit.

Plant.

form circulation of the sap through the oak and ilex, why should the leaves of the oak fall in winter, and not those of the ilex?

"Another argument against an uniform circulation of the sap in trees, as in animals, may be drawn from an experiment, where it was found by the three mercurial gages fixed to the same vine, that while some of its branches changed their state of protruding sap into a state of imbibing, others continued protruding sap; one nine, and the other thirteen days longer."

To this reasoning of Dr. Hales we shall subjoin an experiment made by Mr. Mustel of the Academy of Sciences at Rouen, which seems decisive against the doctrine of circulation. His account of it is as follows.—"On the 12th of January I placed several shrubs in pots against the windows of my hot-house, some within the house and others without it. Through holes made for this purpose in the panes of glass, I passed a branch of each of the shrubs, so that those on the inside had a branch without, and those on the outside one within; after this, I took care that the holes should be exactly closed and luted. This inverse experiment, I thought, if followed closely, could not fail affording sufficient points of comparison, to trace out the differences, by the observation of the effects.

"The 20th of January, a week after this disposition, all the branches that were in the hot-house began to disclose their buds. In the beginning of February there appeared leaves; and towards the end of it, shoots of a considerable length, which presented the young flowers. A dwarf apple-tree, and several rose-trees, being submitted to the same experiment, showed the same appearance then as they commonly put on in May; in short, all the branches which were within the hot-house, and consequently kept in the warm air, were green at the end of February, and had their shoots in great forwardness. Very different were those parts of the same tree which were without and exposed to the cold. None of these gave the least sign of vegetation; and the frost, which was intense at that time, broke a rose-pot placed on the outside, and killed some of the branches of that very tree which, on the inside, was every day putting forth more and more shoots, leaves, and buds, so that it was in full vegetation on one side, whilst frozen on the other.

"The continuance of the frost occasioned no change in any of the internal branches. They all continued in a very brisk and verdant state, as if they did not belong to the tree which, on the outside, appeared in the state of the greatest suffering. On the 15th of March, notwithstanding the severity of the season, all was in full bloom. The apple-tree had its root, its stem, and part of its branches, in the hot-house. These branches were covered with leaves and flowers; but the branches of the same tree, which were carried on the outside, and exposed to the cold air, did not in the least partake of the activity of the rest, but were absolutely in the same state which all trees are in during winter. A rose-tree, in the same position, showed long shoots with leaves and buds; it had even shot a vigorous branch upon its stalk; whilst a branch which passed through to the outside had not begun to produce any thing, but was in the same state with other rose-trees left in the ground. This branch is four lines in diameter, and 18 inches high.

Plant.

"The rose-tree on the outside was in the same state; but one of its branches drawn through to the inside of the hot-house was covered with leaves and rose-buds. It was not without astonishment that I saw this branch shoot as briskly as the rose-tree which was in the hot-house, whose roots and stalk, exposed as they were to the warm air, ought, it should seem, to have made it get forwarder than a branch belonging to a tree, whose roots, trunk, and all its other branches, were at the very time frost-nipped. Notwithstanding this, the branch did not seem affected by the state of its trunk; but the action of the heat upon it produced the same effect as if the whole tree had been in the hot-house."

Of the Perpendicularity of PLANTS.—This is a curious phenomenon in natural history, which was first observed by M. Dodart, and published in an essay on the affectation of perpendicularity observed in the stems or stalks of all plants, in the roots of many, and even in their branches, as much as possible. Though almost all plants rise a little crooked, yet the stems shoot up perpendicularly, and the roots sink down perpendicularly: even those, which by the declivity of the soil come out inclined, or those which are diverted out of the perpendicular by any violent means, again redress and straighten themselves and recover their perpendicularity, by making a second and contrary bend or elbow without rectifying the first. We commonly look upon this affectation without any surprise; but the naturalist who knows what a plant is, and how it is formed, finds it a subject of astonishment.

Each seed we know contains in it a little plant, already formed, and needing nothing but to be unfolded; the little plant has its root; and the pulp, which is usually separated into two lobes, is the foundation of the first food it draws by its root when it begins to germinate. If a seed in the earth therefore be disposed so as that the root of the little plant be turned downwards, and the stem upwards, and even perpendicularly upwards, it is easy to conceive that the little plant coming to unfold itself, its stalk and root need only follow the direction they have to grow perpendicularly. But we know that the seeds of plants, whether sown of themselves or by man, fall in the ground at random; and among the great variety of situations with regard to the stalk of their plant, the perpendicular one upwards is but one. In all the rest, therefore, it is necessary that the stalk rectify itself, so as to get out of the ground: but what force effects this change, which is unquestionably a violent action? Does the stalk find a less load of earth above it, and therefore go naturally that way where it finds the least obstacle? Were this so, the little root, when it happens to be uppermost, must also follow that direction, and mount up.

To account for two such different actions, M. Dodart supposes that the fibres of the stalks are of such a nature as to be contracted and shortened by the heat of the sun, and lengthened out by the moisture of the earth; and, on the contrary, that the fibres of the roots are contracted by the moisture of the earth, and lengthened by the heat of the sun. When the plantule therefore is inverted, and the root at the top, the fibres which compose one of the branches of the root are not alike exposed to the moisture of the earth, the lower part being more exposed than the upper. The lower must of course contract the most; and this contraction is again promoted by the lengthening of the upper, where-

*Memoires de
l'Acad.
Royal des
Sciences, an-
1708.*

Plant.

on the sun acts with the greatest force. This branch of the root must therefore recoil towards the earth, and, insinuating through the pores thereof, must get underneath the bulb, &c. By inverting this reasoning we discover how the stalk comes to get uppermost.

We suppose then that the earth attracts the root to itself, and that the sun contributes to its descent; and, on the other hand, that the sun attracts the stem, and the earth contributes to send it towards the same. With respect to the straightening of the stalks in the open air, our author imagines that it arises from the impression of external causes, particularly the sun and rain. For the upper part of a stalk that is bent is more exposed to the rain, dew, and even the sun, &c. than the under; and these causes, in a certain structure of the fibres, both equally tend to straighten the part most exposed by the shortening they successively occasion in it; for moisture shortens by swelling and heat by dissipating. What that structure is which gives the fibres such different qualities, or whereon it depends, is a mystery as yet beyond our depth.

M. de la Hire accounts for the perpendicularity of the stems or stalks of plants in this manner: he supposes that the root of plants draws a coarser and heavier juice, and the stem and branches a finer and more volatile one. Most naturalists indeed conceive the root to be the stomach of the plant, where the juices of the earth are subtilized so as to become able to rise through the stem to the extremity of the branches. This difference of juices supposes larger pores in the roots than the stalk, &c. and, in a word, a different contexture. This difference must be found even in the little invisible plant inclosed in the seed: in it, therefore, we may conceive a point of separation; such as, that all on one side, for example the root, shall be unfolded by the grosser juices, and all on the other side by the more subtle ones. Suppose the plantule, when its parts begin to unfold, to be entirely inverted, the root at the top, and the stalk below; the juices entering the root will be coarsest, and when they have opened and enlarged the pores so as to admit juices of a determinate weight, those juices pressing the root more and more will drive it downwards; and this will increase as the root is more extended or enlarged: for the point of separation being conceived as the fixed point of a lever, they will act by the longer arm. The volatile juices at the same time having penetrated the stalk, will give it a direction from below upwards; and, by reason of the lever, will give it more and more every day. The little plant is thus turned on its fixed point of separation till it become perfectly erect.

When the plant is thus erected, the stalk should still rise perpendicularly, in order to give it the more firm biding, and enable it to withstand the effort of wind and weather. M. Parent thus accounts for this effect: If the nutritious juice which arrived at the extremity of a rising stalk evaporate, the weight of the air which encompasses it on all sides will make it ascend vertically: but if, instead of evaporating, it congeal, and remain fixed to that extremity whence it was ready to go off, the weight of the air will give it the same direction; so that the stalk will have acquired a small new part vertically laid over it, just as the flame in a candle held in any way obliquely to the horizon still continues vertical by the pressure of the atmosphere. The new drops of

Plant.

juice that succeed will follow the same direction; and as all together form the stalk, that must of course be vertical, unless some particular circumstance intervene.

The branches, which are at first supposed to proceed laterally out of the stalk in the first embryo of the plant, though they should even come out in an horizontal direction, must also raise themselves upwards by the constant direction of the nutritious juice, which at first scarce meets any resistance in a tender supple branch; and afterwards, even though the branch grow more firm, it will act with the more advantage; since the branch, being become longer, furnishes it with a longer arm or lever. The slender action of even a little drop becomes very considerable by its continuity, and by the assistance of such circumstances. Hence may we account for that regular situation and direction of the branches, since they all make nearly the same constant angle of 45° with the stem, and with one another.

M. Astruc accounts for the perpendicularity of the stems, and their redressing themselves, thus: 1. He thinks the nutritious juice arises from the circumference of the plant, and terminates in the pith: And, 2. That fluids, contained in tubes either parallel or oblique to the horizon, gravitate on the lower part of the tubes, and not at all on the upper. Hence it follows, that, in a plant placed either obliquely or parallel to the horizon, the nutritious juice will act more on the lower part of the canals than on the upper; and by this means they will insinuate more into the canals communicating therewith, and be collected more copiously therein: thus the parts on the lower side will receive more accretion and be more nourished than those on the upper, the extremity of the plant will therefore be obliged to bend upwards.

This principle brings the seed into its due situation at first. In a bean planted upside down, the plume and radicle may be seen with the naked eye shooting at first directly for about an inch; after which they begin to bend, the one downward, and the other upward. The same is the case in a heap of barley to be made into malt, or in a quantity of acorns laid to sprout in a moist place, &c. Each grain of barley and each acorn has a different situation; and yet every sprout tends directly upward, and every root downward, and the curvity or bend they make is greater or less as their situation approaches more or less to the direction wherein no curvature at all would be necessary. But two such opposite motions cannot possibly arise without supposing some difference between the two parts: the only one we know of is, that the plume is fed by a juice imported to it by tubes parallel to its sides, whereas the radical imbibes its nourishment at every pore in its surface. When the plume therefore is either parallel or inclined to the horizon, the nutritious juice, feeding the lower parts more than the upper, will determine its extremes to turn upward, for the reasons before given. On the contrary, when the radicle is in the like situation, the nutritive juice penetrating through the upper part more copiously than through the under, there will be a greater accretion of the former than of the latter; and the radicle will therefore be bent downwards, and this mutual curvity of the plume and radicle must continue till such time as their sides are no longer alike, which cannot be till they are perpendicular.

Of the Food of PLANTS.—This hath been so fully discussed

Plants.

Part i.
§ 1.

discussed under the article AGRICULTURE †, that little remains to be said upon the subject in this place. The method of making dephlogisticated or vital air *de novo*, is now so much improved, that numberless experiments may be made with it both on animals and vegetables. It appears, indeed, that these two parts of the creation are a kind of counterbalance to one another; and the noxious parts or excrements of the one prove salutary food to the other. Thus, from the animal body continually pass off certain effluvia, which vitiate or *phlogisticate* the air. Nothing can be more prejudicial to animal life than an accumulation of these effluvia: on the other hand, nothing is more favourable to vegetables than those excrementitious effluvia of animals; and accordingly they greedily absorb them from the earth, or from the air. With respect to the excrementitious parts of living vegetables, the case is reversed. The purest air is the common effluvium which passes off from vegetables; and this, however favourable to animal life, is by no means so to vegetable; whence we have an additional proof of the doctrine concerning the food of plants delivered under the article AGRICULTURE.

With regard to the effects of other kinds of air on vegetation, a difference of some consequence took place between Dr Priestley and Dr Percival. The former, in the first volume of his Experiments and Observations on Air, had asserted that fixed air is fatal to vegetable as well as to animal life. This opinion, however, was opposed by Dr Percival, and the contrary one adopted by Dr Hunter of York in the Georgical Essays, vol. v. The experiments related by these two gentlemen would indeed have been decisive, had they been made with sufficient accuracy. That this was the case, however, Dr Priestley denies; and in the 3d volume of his Treatise on Air has fully detected the mistakes in Dr Percival's Experiments; which proceeded in fact from his having used, not fixed air, but common air mixed with a small quantity of fixed air. His experiments, when repeated with the purest fixed air, and in the most careful manner, were always attended with the same effect, namely, the killing of the plant.

It had also been asserted by Drs Percival and Hunter, that water impregnated with fixed air was more favourable to vegetation than simple water. This opinion was likewise examined by Dr Priestley: however, his experiments were indecisive; but seem rather unfavourable to the use of fixed air than otherwise.

Another very remarkable fact with regard to the food of plants has been discovered by Dr Priestley; namely, that some of them, such as the willow, comfrey, and duck-weed, are nourished by inflammable air. The first, he says, flourishes in this species of air so remarkably, that, "it may be said to feed upon it with great avidity. This process terminates in the change of what remains of the inflammable air into phlogisticated air, and sometimes into a species of air as good as common air, or even better; so that it must be the *inflammable principle* in the air that the plant takes, converting it, no doubt, into its proper nourishment."

What the followers of Stahl call phlogisticated air and inflammable air, are so closely allied to each other, that it is no wonder they should serve promiscuously for the food of plants. The reason why both are not agreeable to all kinds of plants, most probably is the different

quantity of phlogistic matter contained in them, and the different action of the latent fire they contain: for all plants do not require an equal quantity of nourishment; and such as require but little, will be destroyed by having too much. The action of heat also is essentially necessary to vegetation; and it is probable that very much of this principle is absorbed from the air by vegetables. But if the air by which plants are partly nourished contains too much of that principle, it is very probable that they may be destroyed from this cause as well as the other; and thus inflammable air, which contains a vast quantity of that active principle, may destroy such plants as grow in a dry soil, though it preserves those which grow in a wet one. See VEGETATION.

Dissemination of PLANTS.—So great are the prolific powers of the vegetable kingdom, that a single plant almost of any kind, if left to itself, would, in a short time, over-run the whole world. Indeed, supposing the plant to have been only a single annual, with two seeds, it would, in 20 years, produce more than a million of its own species; what numbers then must have been produced by a plant whose seeds are so numerous as many of those with which we are acquainted? See *NATURAL History*, sect. iii. p. 654, &c. In that part of our work we have given particular examples of the very prolific nature of plants, which we need not repeat here; and we have made some observations on the means by which they are carried to distant places. This is a very curious matter of fact, and as such we shall now give a fuller account of it.

If nature had appointed no means for the scattering of these numerous seeds, but allowed them to fall down in the place where they grew, the young vegetables must of necessity have choaked one another as they grew up, and not a single plant could have arrived at perfection. But so many ways are there appointed for the dissemination of plants, that we see they not only do not hinder each others growth, but a single plant will in a short time spread through different countries. The most evident means for this purpose are,

1. The force of the air.—That the efficacy of this may be the greater, nature has raised the seeds of vegetables upon stalks, so that the wind has thus an opportunity of acting upon them with the greater advantage. The seed-capsules also open at the apex, lest the ripe seeds should drop out without being widely dispersed by the wind. Others are furnished with wings, and a pappous down, by which, after they come to maturity, they are carried up into the air, and have been known to fly the distance of 50 miles: 138 genera are found to have winged seeds.

2. In some plants the seed-vessels open with violence when the seeds are ripe, and thus throw them to a considerable distance; and we have an enumeration of 50 genera whose seeds are thus dispersed.

3. Other seeds are furnished with hooks, by which, when ripe, they adhere to the coats of animals, and are carried by them to their lodging places. Linnæus reckons 50 genera armed in this manner.

4. Many seeds are dispersed by means of birds and other animals; who pick up the berries, and afterwards eject the seeds uninjured. Thus the fox disseminates the privet, and man many species of fruit. The plants found growing upon walls and houses, on the tops of

Plants.

Plants. high rocks, &c. are mostly brought there by birds; and it is universally known, that by manuring a field with new dung, innumerable weeds will spring up which did not exist there before: 193 species are reckoned up which may be disseminated in this manner.

5. The growth of other seeds is promoted by animals in a different way. While some are eaten, others are scattered and trodden into the ground by them. The squirrel gnaws the cones of the pine, and many of the seeds fall out. When the loxica eats off their bark, almost his only food, many of their seeds are committed to the earth, or mixed in the morass with moss, where he had retired. The glandularia, when she hides up her nuts, often forgets them, and they strike root. The same is observable of the walnut; mice collect and bury great quantities of them, and being afterwards killed by different animals, the nuts germinate.

6. We are astonished to find mosses, fungi, byssus, and mucor, growing everywhere; but it is for want of reflecting that their seeds are so minute that they are almost invisible to the naked eye. They float in the air like atoms, and are dropped everywhere, but grow only in those places where there was no vegetation before; and hence we find the same mosses in North America and in Europe.

Amn. Academ. 7. Seeds are also dispersed by the ocean, and by rivers. "In Lapland (says Linnæus), we see the most evident proofs how far rivers contribute to deposite the seeds of plants. I have seen Alpine plants growing upon their shores frequently 36 miles distant from the Alps; for their seeds falling into the rivers, and being carried along and left by the stream, take root there.—We may gather likewise from many circumstances how much the sea furthers this business.—In Roslagia, the island of Græscæ, Oeland, Gothland, and the shores of Scania, there are many foreign and German plants not yet naturalized in Sweden. The centaury is a German plant, whose seeds being carried by the wind into the sea, the waves landed this foreigner upon the coasts of Sweden. I was astonished to see the veronica maritima, a German plant, growing at Tornea, which hitherto had been found only in Græscæ: the sea was the vehicle by which this plant was transported thither from Germany; or possibly it was brought from Germany to Græscæ, and from thence to Tornea. Many have imagined, but erroneously, that seed corrupts in water, and loses its principle of vegetation. Water at the bottom of the sea is seldom warm enough to destroy seeds; we have seen water cover the surface of a field for a whole winter, while the seed which it contained remained unhurt, unless at the beginning of spring the waters were let down so low by drains, that the warmth of the sunbeams reached to the bottom. Then the seeds germinate, but presently become putrescent; so that for the rest of the year the earth remains naked and barren.

Plants. Rain and showers carry seeds into the cracks of the earth, streams, and rivers; which last, conveying them to a distance from their native places, plant them in a foreign soil."

8. Lastly, some seeds assist their projection to a distance in a very surprising manner. The crupina, a species of centaury, has its seeds covered over with erect bristles, by whose assistance it creeps and moves about in such a manner, that it is by no means to be kept in the hand. If you confine one of them between the stocking and the foot, it creeps out either at the sleeve or neck-band, travelling over the whole body. If the bearded oat, after harvest, be left with other grain in the barn, it extricates itself from the glume; nor does it stop in its progress till it gets to the walls of the building. Hence, says Linnæus, the Dalecarlian, after he has cut and carried it into the barn, in a few days finds all the glumes empty, and the oats separate from them; for every oat has a spiral arista or beard annexed to it, which is contracted in wet, and extended in dry weather. When the spiral is contracted, it drags the oat along with it: the arista being bearded with minute hairs pointing downward, the grain necessarily follows it; but when it expands again, the oat does not go back to its former place, the roughness of the beard the contrary way preventing its return. If you take the seeds of equisetum, or fern, these being laid upon paper, and viewed in a microscope, will be seen to leap over any obstacle as if they had feet; by which they are separated and dispersed one from another; so that a person ignorant of this property would pronounce these seeds to be so many mites or small insects.

We cannot finish this article without remarking, that many ingenious men (A) believe that plants have a power of perception. Of this opinion we shall now give an account from the second volume of the Manchester Transactions, where we find some *speculations on the perceptive power of vegetables* by Dr Percival, who attempts to show, by the several analogies of organization, life, instinct, spontaneity, and self-motion, that plants, like animals, are endued with the powers both of perception and enjoyment. The attempt is ingenious, and is ingeniously supported, but in our opinion fails to convince. That there is an analogy between animals and vegetables is certain; but we cannot from thence conclude that they either perceive or enjoy. Botanists have, it is true, derived from *anatomy* and *physiology*, almost all the terms employed in the description of plants. But we cannot from thence conclude, that their organization, tho' it bears an analogy to that of animals, is the sign of a *living principle*, if to this *principle* we annex the idea of *perception*; yet so fully is our author convinced of the truth of it, that he does not think it extravagant to suppose, that, in some future period, perceptivity may be discovered to extend even beyond the limits now assigned to vegetable life. Corallines, madrepores, millepores, and sponges, were formerly considered as fossil bodies;

(A) The ingenious Dr Bell held this opinion, as appears from the close of his *Thesis de Physiologia Plantarum*, which was published at Edinburgh, June 1777, and a translation of which by Dr Currie we find in the second volume of the Manchester Transactions, where our readers will also find memoirs of its author. Dr Currie informs us, that Dr Hope, the late excellent professor of botany in Edinburgh, in his course of lectures, used to speak of Dr Bell with the highest esteem; but did not approve of the idea which he entertained respecting the feeling or perception of plants.

Plants.

dies: but the experiments of Count Marfigli evinced, that they are endued with life, and led him to class them with the maritime plants. And the observations of Ellis, Jussieu, and Peyssonel, have since raised them to the rank of animals. The detection of error, in long established opinions concerning one branch of natural knowledge, justifies the suspicion of its existence in others, which are nearly allied to it. And it will appear from the prosecution of our inquiry into the instincts, spontaneity, and self-moving power of vegetables, that the suspicion is not without foundation.

He then goes on to draw a comparison between the instincts of animals and those of vegetables: the calf, as soon as it comes into the world, applies to the teats of the cow; and the duckling, though hatched under a hen, runs to the water.

"Instincts analogous to these (says our author), operate with equal energy on the vegetable tribe. A seed contains a germ, or plant in miniature, and a radicle, or little root, intended by nature to supply it with nourishment. If the seed be sown in an inverted position, still each part pursues its proper direction. The plumula turns upward, and the radicle strikes downward into the ground. A hop-plant, turning round a pole, follows the course of the sun, from south to west, and soon dies, when forced into an opposite line of motion: but remove the obstacle, and the plant will quickly return to its ordinary position. The branches of a honey-suckle shoot out longitudinally, till they become unable to bear their own weight; and then strengthen themselves, by changing their form into a spiral: when they meet with other living branches, of the same kind, they coalesce, for mutual support, and one spiral turns to the right and the other to the left; thus seeking, by an instinctive impulse, some body on which to climb, and increasing the probability of finding one by the diversity of their course: for if the auxiliary branch be dead, the other uniformly winds itself round from the right to the left.

"These examples of the instinctive economy of vegetables have been purposely taken from subjects familiar to our daily observation. But the plants of warmer climates, were we sufficiently acquainted with them, would probably furnish better illustrations of this acknowledged power of animality: and I shall briefly recite the histo-

ry of a very curious exotic, which has been delivered to us from good authority; and confirmed by the observations of several European botanists."

The Doctor then goes on to give a description of the *dionæa muscipula* (a), for which see vol. vi. p. 32. and concludes, that if he has furnished any presumptive proof of the instinctive power of vegetables, it will necessarily follow that they are endued with some degree of spontaneity. More fully to evince this, however, the Doctor points out a few of those phenomena in the vegetable kingdom which seem to indicate spontaneity.—"Several years ago (says he), whilst engaged in a course of experiments to ascertain the influence of fixed air on vegetation, the following fact repeatedly occurred to me. A sprig of mint, suspended by the root, with the head downwards, in the middle glass vessel of Dr Nooth's machine, continued to thrive vigorously, without any other pabulum than what was supplied by the stream of mephitic gas to which it was exposed. In 24 hours the stem formed into a curve, the head became erect, and gradually ascended towards the mouth of the vessel; thus producing, by successive efforts, a new and unusual configuration of its parts. Such exertions in the sprig of mint, to rectify its inverted position, and to remove from a foreign to its natural element, seems to evince evolution to avoid what was evil, and to recover what had been experienced to be good. If a plant, in a garden-pot, be placed in a room which has no light except from a hole in the wall, it will shoot towards the hole, pass through it into the open air, and then vegetate upwards in its proper direction. Lord Kames relates, that, 'amongst the ruins of New Abbey, formerly a monastery in Galloway, there grows on the top of a wall a plane tree, 20 feet high. Straited for nourishment in that barren situation, it several years ago directed roots down the side of the wall till they reached the ground ten feet below: and now the nourishment it afforded to these roots, during the time of descending, is amply repaid; having every year since that time made vigorous shoots. From the top of the wall to the surface of the earth, these roots have not thrown out a simple fibre, but are now united into a pretty thick hard root.

"The regular movements by which the sun-flower presents its splendid disk to the sun have been known to

B 2

naturalists,

(a) Dr Watson, the present bishop of Landaff, who has espoused the same side of the question with Dr Percival (see the 5th vol. of his *Chemical Essays*), reasons thus on the motions of vegetables. "Whatever can produce any effect (says he) upon an animal organ as the impact of external bodies, heat and cold, the vapour of burning sulphur, of volatile alkali, want of air, &c. are found to act also upon the plants called *sensitive*. But not to insist upon any more instances, the muscular motions of the *dionæa muscipula* lately brought into Europe from America, seem far superior in quickness to those of a variety of animals. Now to refer the muscular motions of shell-fish and zoophytes to an internal principle of volition, to make them indicative of the perceptivity of the being, and to attribute the more notable ones of vegetables to certain mechanical dilatations and contractions of parts occasioned by external impulse, is to err against that rule of philosophizing which assigns the same causes for effects of the same kind. The motions in both cases are equally accommodated to the preservation of the being to which they belong, are equally distinct and uniform, and should be equally derived from mechanism, or equally admitted as criterions of perception.

"I am sensible that these and other similar motions of vegetables may by some be considered as analogous to the automatic or involuntary motions of animals; but as it is not yet determined amongst the physiologists, whether the motion of the heart, the peristaltic motion of the bowels, the contractions observable upon external impulse in the muscles of animals deprived of their heads and hearts, be attributable to an irritability unaccompanied with perceptivity, or to an uneasy sensation, there seems to be no reason for entering into so obscure a disquisition; especially since irritability, if admitted as the cause of the motions of vegetables, must *a fortiori* be admitted as the cause of the less exquisite and discernible motions of beings universally referred to the animal kingdom."

Plants.

Plants.

naturalists, and celebrated by poets, both of ancient and modern times. Ovid founds upon it a beautiful story; and Thomson describes it as an attachment of love to the celestial luminary.

- ‘ But one, the lofty follower of the sun,
- ‘ Sad when he sets, shuts up her yellow leaves,
- ‘ Drooping all night; and when he warm returns,
- ‘ Points her enamour’d bosom to his ray.’

SUMMER, line 216.

‡ See *Pen-
netula, Of-
srea, Myti-
lus, &c.*

Dr Percival next touches on motion; he mentions corallines, seapens ‡, oysters, &c. as endued with the power of motion in a very small degree, and then he speaks in the following manner. “ Mr Miller (says he), in his late account of the island of Sumatra, mentions a species of coral, which the inhabitants have mistaken for a plant, and have denominated it *lalan-cout*, or sea-grass. It is found in shallow bays, where it appears like a straight stick, but when touched withdraws itself into the sand. Now if self-moving faculties like these indicate animality, can such a distinction be denied to vegetables, possessed of them in an equal or superior degree? The water-lily, be the pond deep or shallow in which it grows, pushes up its flower-stems till they reach the open air, that the farina fecundans may perform without injury its proper office. About seven in the morning the stalk erects itself, and the flowers rise above the surface of the water: in this state they continue till four in the afternoon, when the stalk becomes relaxed, and the flowers sink and close. The motions of the sensitive plant have been long noticed with admiration, as exhibiting the most obvious signs of perceptivity. And if we admit such motions as criteria of a like power in other beings, to attribute them in this instance to mere mechanism, actuated solely by external impulse, is to deviate from the soundest rule of philosophizing, which directs us not to multiply causes when the effects appear to be the same. Neither will the laws of electricity better solve the phenomena of this animated vegetable: for its leaves are equally affected by the contact of electric and non-electric bodies; show no change in their sensibility whether the atmosphere be dry or moist; and instantly close when the vapour of volatile alkali or the fumes of burning sulphur are applied to them. The powers of chemical stimuli to produce contractions in the fibres of this plant may perhaps lead some philosophers to refer them to the *vis insita*, or irritability, which they assign to certain parts of organized matter, totally distinct from, and independent of, any sentient energy. But the hypothesis is evidently a solecism, and refutes itself. For the presence of irritability can only be proved by the experience of irritations, and the idea of irritation involves in it that of feeling.

“ But there is a species of the order of decandria,

which constantly and uniformly exerts a self-moving power, uninfluenced either by chemical stimuli, or by any external impulse whatsoever. This curious shrub, which was unknown to Linnæus, is a native of the East Indies, but has been cultivated in several botanical gardens here. I had an opportunity of examining it in the collection of the late Dr Brown. See HEDYSARUM.— I cannot better comment on this wonderful degree of vegetable animation than in the words of Cicero. *Inanimum est omne quod pulsū agitur externo; quod autem est animal, id motu cietur interiore et suo.*

“ I have thus attempted, with the brevity prescribed by the laws of this society, to extend our views of animated nature; to gratify the mind with the contemplation of multiplied accessions to the general aggregate of felicity; and to exalt our conceptions of the wisdom, power, and beneficence of God. In an undertaking never yet accomplished, disappointment can be no disgrace: in one directed to such noble objects, the motives are a justification, independently of success. Truth, indeed, obliges me to acknowledge, that I review my speculations with much diffidence; and that I dare not presume to expect they will produce any permanent conviction in others, because I experience an instability of opinion in myself. For, to use the language of Tully, *Nescio quomodo, dum lego, assentior; cum posui librum, assensio omnis illa elabitur.*—But this scepticism is perhaps to be ascribed to the influence of habitual preconceptions, rather than to a deficiency of reasonable proof. For besides the various arguments which have been advanced in favour of vegetable perceptivity, it may be further urged, that the hypothesis recommends itself by its consonance to those higher analogies of nature, which lead us to conclude, that the greatest possible sum of happiness exists in the universe. The bottom of the ocean is overspread with plants of the most luxuriant magnitude. Immense regions of the earth are covered with perennial forests. Nor are the Alps, or the Andes, destitute of herbage, though buried in deeps of snow. And can it be imagined that such profusion of life subsists without the least sensation or enjoyment? Let us rather, with humble reverence, suppose, that vegetables participate, in some low degree, of the common allotment of vitality; and that our great Creator hath apportioned good to all living things, ‘ in number, weight, and measure.’ See SENSITIVE PLANT, MIMOSA, DIONÆA Muscipula, Vegetable MOTION, &c.

To these ingenious and spirited observations, we shall subjoin nothing of our own, but leave our readers to determine for themselves (c). Speculations of this kind, when carried on by sober men, will never be productive of bad consequences; but by the subtle sceptic, or the more unwary inquirer, they may be made the engine of very dangerous errors. By this we do not mean to in-

Plants.

(c) In the 2d volume of *Transactions of the Linnæan Society*, we find Dr Percival’s reasoning very ably combated, as far as he draws his consequences from the external motions of plants; where it is argued, that these motions, though in some respects similar to those of animals, can and ought to be explained, without concluding that they are endowed either with perception or volition. Mr Townson concludes his paper in these words: “ When all is considered (says he), I think we shall place this opinion amongst the many ingenious flights of the imagination, and soberly follow that blind impulse which leads us naturally to give sensation and perceptivity to animals, and to deny it to vegetables; and so still say with Aristotle, and our great master, Linnæus, *Vegetabilia crescunt & vivunt; animalia crescunt, vivunt, & sentiunt.*”

Plants. sinuate that the spirit of inquiry should be suppressed, because that spirit, in the hands of weak or of wicked men, may be abused. By those, however, who know the bad consequences that may be drawn, and indeed that have been drawn, from the opinions we have now given an account of, our caution will not be deemed impertinent. See *PHYSIOLOGY* *passim*, and particularly n° 42, and note (A), p. 678.

PLANTS growing on Animals. See *INSECTS* giving root to *Plants*.

Sexes of PLANTS. See *SEXES*, and *BOTANY*, sect. v.

Colours of PLANTS. See *COLOUR* of *Plants*.

Colours extracted from PLANTS. See *COLOUR-making*, n° 35, et seq.

Method of Drying and Preserving PLANTS for Botanists.—Many methods have been devised for the preservation of plants: we shall relate only those that have been found most successful.

Vitthering's botanical arrangement, Introd. 48.
First prepare a press, which a workman will make by the following directions. Take two planks of a wood not liable to warp. The planks must be two inches thick, 18 inches long, and 12 inches broad. Get four male and four female screws, such as are commonly used for securing sash-windows. Let the four female screws be let into the four corners of one of the planks, and corresponding holes made through the four corners of the other plank for the male screws to pass through, so as to allow the two planks to be screwed tightly together. It will not be amiss to face the bearing of the male screws upon the wood with iron plates; and if the iron plates went across from corner to corner of the wood, it would be a good security against the warping.

Secondly, get half a dozen quires of large soft spongy paper (such as the stationers call *blossom blotting paper*, is the best), and a few sheets of strong pasteboard.

The plants you wish to preserve should be gathered in a dry day, after the sun hath exhales the dew; taking particular care to collect them in that state wherein their generic and specific characters are most conspicuous. Carry them home in a tin-box nine inches long, four inches and a half wide, and one inch and a half deep. Get the box made of the thinnest tinned iron that can be procured; and let the lid open upon hinges. If any thing happens to prevent the immediate use of the specimens you have collected, they will be kept fresh two or three days in this box much better than by putting them in water. When you are going to preserve them, suffer them to lie upon a table until they become limber; and then they should be laid upon a pasteboard, as much as possible in their natural form, but at the same time with a particular view to their generic and specific characters. For this purpose it will be advisable to separate one of the flowers, and to display the generic character. If the specific character depends upon the flower or upon the root, a particular display of that will be likewise necessary. When the plant is thus disposed upon the pasteboard, cover it with eight or ten layers of spongy paper, and put it into the press. Exert only a small degree of pressure for the first two or three days; then examine it, unfold any unnatural plaits, rectify any mistakes, and, after putting fresh paper over it, screw the press harder. In about three days more separate the plant from the pasteboard,

if it is sufficiently firm to allow of a change of place; put it upon a fresh pasteboard, and, covering it with fresh blossom-paper, let it remain in the press a few days longer. The press should stand in the sun-shine, or within the influence of a fire.

When it is perfectly dry, the usual method is to fasten it down, with paste or gum-water, on the right-hand inner page of a sheet of large strong writing-paper. It requires some dexterity to glue the plant neatly down, so that none of the gum or paste may appear to defile the paper. Press it gently again for a day or two, with a half sheet of blossom-paper betwixt the folds of the writing-paper. When it is quite dry, write upon the left-hand inner page of the paper the name of the plant; the specific character; the place where, and the time when, it was found; and any other remarks you may think proper. Upon the back of the same page, near the fold of the paper, write the name of the plant, and then place it in your cabinet. A small quantity of finely powdered arsenic, or corrosive sublimate, is usually mixed with the paste or gum-water, to prevent the devastations of insects; but the seeds of slaves-acre finely powdered will answer the same purpose, without being liable to corrode or to change the colour of the more delicate plants. Some people put the dried plants into the sheets of writing paper, without fastening them down at all; and others only fasten them by means of small slips of paper, pasted across the stem or branches. Where the species of any genus are numerous, and the specimens are small, several of them may be put into one sheet of paper.

Another more expeditious method is to take the plants out of the press after the first or second day; let them remain upon the pasteboard; cover them with five or six leaves of blossom paper, and iron them with a hot smoothing iron until they are perfectly dry. If the iron is too hot, it will change the colours; but some people, taught by long practice, will succeed very happily. This is quite the best method to treat the orchis and other slimy mucilaginous plants.

Another method is to take the plants when fresh gathered, and, instead of putting them into the press, immediately to fasten them down to the paper with strong gum water: then dip a camel-hair pencil into spirit-varnish, and varnish the whole surface of the plant two or three times over. This method succeeds very well with plants that are readily laid flat, and it preserves their colours better than any other. The spirit-varnish is made thus. To a quart of highly rectified spirit of wine put five ounces of gum sandarach; two ounces of mastic in drops; one ounce of pale gum elemi, and one ounce of oil of spike-lavender. Let it stand in a warm place, and shake it frequently to expedite the solution of the gums.

Where no better convenience can be had, the specimens may be disposed systematically in a large folio book; but a vegetable cabinet is upon all accounts more eligible. In Plate CCCXCVII. there is a section of a cabinet, in the true proportions it ought to be made, for containing a complete collection of British plants. By the assistance of this drawing, and the adjoining scale, a workman will readily make one. The drawers must have backs and sides, but no other front than a small

Plants. small ledge. Each drawer will be 14 inches wide, and 10 inches from the back to the front, after allowing half an inch for the thickness of the two sides, and a quarter of an inch for the thickness of the back. The sides of the drawers, in the part next the front, must be sloped off in a serpentine line, something like what the workmen call an *ogee*. The bottoms of the drawers must be made to slide in grooves cut in the uprights, so that no space may be lost betwixt drawer and drawer. After allowing a quarter of an inch for the thickness of the bottom of each drawer, the clear perpendicular space in each must be as in the following table.

I. Two tenths of an inch.	XIV. Three inches and eight tenths.
II. One inch and two-tenths.	XV. Three inches and four tenths.
III. Four inch, and six tenths.	XVI. One inch and three tenths.
IV. Two inches and three-tenths.	XVII. Two inches and eight tenths.
V. Seven inches and eight tenths.	XVIII. Six-tenths of an inch.
VI. Two inches and two-tenths.	XIX. Ten inches
VII. Two tenths of an inch.	XX. One inch and nine-tenths.
VII. One inch and four-tenths.	XXI. Four inches and four tenths.
IX. Two-tenths of an inch.	XXII. Two inches and six-tenths.
X. Two inches and eight-tenths.	XXIII. One inch and two-tenths.
XI. One inch and two-tenths.	XXIV. Seventeen inches.
XII. Three inches and five-tenths.	
XIII. Two inches and four-tenths.	

This cabinet shuts up with two doors in front; and the whole may stand upon a base, containing a few drawers for the reception of duplicates and papers.

Fossil PLANTS. Many species of tender and herbaceous plants are found at this day, in great abundance, buried at considerable depths in the earth, and converted, as it were, into the nature of the matter they lie among; fossil wood is often found very little altered, and often impregnated with substances of almost all the different fossil kinds, and lodged in all the several strata, sometimes firmly imbedded in hard matter; sometimes loose: but this is by no means the case with the tenderer and more delicate subjects of the vegetable world. These are usually immerfed either in a blackish slaty substance, found lying over the strata of coal, else in loose nodules of ferruginous matter of a pebble-like form, and they are always altered into the nature of the substance they lie among: what we meet with of these are principally of the fern kind; and what is very singular, though a very certain truth, is, that these are principally the ferns of American growth, not those of our own climate. The most frequent fossil plants are the polypody, spleenwort, ofmund, trichomanes, and the several larger and smaller ferns; but besides these there are also found pieces of the equisetum or horse-tail, and joints of the stellated plants, as the clivers, madder, and the like; and these have been too often mistaken for flowers; sometimes there are also found complete grasses, or parts of them, as also reeds, and other watery plants; sometimes the ears of corn, and not unfrequently the twigs or bark, and impressions of the bark, and fruit of the pine or fir kind, which have been, from their scaly appearance, mistaken for the skins of fishes; and sometimes, but that very rarely, we meet with mosses and sea-plants.

Many of the ferns not unfrequently found, are of

very singular kinds, and some species yet unknown to us; and the leaves of some appear set at regular distances, with round protuberances and cavities. The stones which contain these plants split readily, and are often found to contain, on one side, the impression of the plant, and on the other the prominent plant itself: and, beside all that have been mentioned, there have been frequently supposed to have been found with us ears of common wheat, and of the maize or Indian corn; the first being in reality no other than the common endmost branches of the firs, and the other the thicker boughs of various species of that and of the pine kind, with their leaves fallen off; such branches in such a state cannot but afford many irregular tubercles and papillæ, and, in some species, such as are more regularly disposed.

These are the kinds most obvious in England; and these are either immerfed in the slaty stone which constitutes whole strata, or in flatted nodules, usually of about three inches broad, which readily split into two pieces on being struck.

They are most common in Kent, on coal-pits near Newcastle, and the forest of Dean in Gloucestershire; but are more or less found about almost all our coal-pits, and many of our iron mines. Though these seem the only species of plants found with us, yet in Germany there are many others, and those found in different substances. A whitish stone, a little harder than chalk, frequently contains them: they are found also often in a grey slaty stone of a firmer texture, not unfrequently in a blackish one, and at times in many others. Nor are the bodies themselves less various here than the matter in which they are contained: the leaves of trees are found in great abundance, among which those of the willow, poplar, whitethorn, and pear trees, are the most common; small branches of box, leaves of the olive-tree, and stalks of garden thyme, are also found there; and sometimes ears of the various species of corn, and the larger as well as the smaller mosses in great abundance.

These seem the tender vegetables, or herbaceous plants, certainly found thus immerfed in hard stone, and buried at great depths in the earth: others of many kinds there are also named by authors; but as in bodies so imperfect errors are easily fallen into, these seem all that can be ascertained beyond mere conjecture.

PLANTS, method of preserving them in their original shape and colour. Wash a sufficient quantity of fine sand, so as perfectly to separate it from all other substances; dry it; pass it through a sieve to clear it from any gross particles which would not rise in the washing: take an earthen vessel of a proper size and form, for every plant and flower which you intend to preserve; gather your plants and flowers when they are in a state of perfection, and in dry weather, and always with a convenient portion of the stalk: heat a little of the dry sand prepared as above, and lay it in the bottom of the vessel, so as equally to cover it; lay the plant or flower upon it, so as that no part of it may touch the sides of the vessel: sift or shake in more of the same sand by little upon it, so that the leaves may be extended by degrees, and without injury, till the plant or flower is covered about two inches thick: put the vessel into a stove, or hot-house, heated by little and little to the 50th degree; let it

Plant
||
lantago.

stand there a day or two, or perhaps more, according to the thickness and succulence of the flower or plant; then gently shake the sand out upon a sheet of paper, and take out the plant, which you will find in all its beauty, the shape as elegant, and the colour as vivid as when it grew.

Some flowers require certain little operations to preserve the adherence of their petals, particularly the tulip; with respect to which it is necessary, before it is buried in the sand, to cut the triangular fruit which rises in the middle of the flower; for the petals will then remain more firmly attached to the stalk.

A hortus siccus prepared in this manner would be one of the most beautiful and useful curiosities that can be.

Moving PLANT. See HEDYSARUM.

Sea PLANTS. See SEA Plants.

Sensitive PLANT. See MIMOSA and SENSITIVE Plant.

PLANT-Lice, Vine-fretters, or Pucerons. See APHIS.

PLANTA, a PLANT. See PLANT.

PLANTA Fœminea, a female plant, is one which bears female flowers only. It is opposed to a male plant, which bears only male flowers; and to an *androgynous* one, which bears flowers of both sexes. Female plants are produced from the same seed with the male, and arrange themselves under the class of *diœcia* in the sexual method.

PLANTAGENET, the surname of the kings of England from Henry II. to Richard III. inclusive. Antiquarians are much at a loss to account for the origin of this name; and the best derivation they can find for it is, that Fulk, the first earl of Anjou of that name, being stung with remorse for some wicked action, went in pilgrimage to Jerusalem as a work of atonement; where, being soundly scourged with broom twigs, which grew plentifully on the spot, he ever after took the surname of *Plantagenet* or *broomstalk*, which was retained by his noble posterity.

PLANTAGO, *PLANTAIN*; a genus of the monogynia order, belonging to the tetrandria class of plants. To this genus Linnæus has joined the coronopus and psyllium of Tournefort. The first of these is called *hartshorn*, the latter *seawort*. Of these there are several distinct species, and some varieties; but as they are rarely cultivated in gardens, we shall not enumerate them here, and shall only mention such of them as grow naturally in Britain. Of the plantain there are the following sorts: The common broad-leaved plantain, called *weybread*; the great hoary plantain, or lambs-tongue; the narrow-leaved plantain, or ribwort; and the following varieties have also been found in England, which are accidental; the besom-plantain and rose-plantain. The plantains grow naturally in pastures in most parts of England, and are frequently very troublesome weeds. The common plantain and ribwort plantain are both used in medicine, and are so well known as to need no description. They are said to be slightly astringent; and the green leaves are commonly applied to fresh wounds by the common people.

Of the coronopus, or buckshorn plantain, there are two varieties growing in England, viz. the common buckshorn, which grows plentifully on heaths everywhere; and the narrow-leaved Welch sort, which is found upon many of the Welch mountains. The first of these was

formerly cultivated as a salad herb in gardens, but has been long banished from thence for its rank disagreeable flavour; it is sometimes used in medicine.—There has been one species of psyllium or seawort found growing naturally in England, which is used in medicine. It was found in the earth thrown out of the bottom of the canals which were dug for the Chelsea water-works, where it grew in great plenty. The seeds of it must have been buried there some ages; for no person remembers any of the plants growing in that neighbourhood before. The seeds of this species are sometimes used, as they are imported from the south of France.

PLANTAIN. See PLANTAGO.

PLANTAIN-Tree. See MUSA.

PLANTATION, in the West Indies, denotes a spot of ground which a planter, or person arrived in a new colony, pitches on to cultivate for his own use, or is assigned for that purpose. However, the term *plantation* is often used in a term synonymous with colony. See COLONY.

PLANTERSHIP, in a general sense, the business of a planter.

PLANTERSHIP, in the West Indies, denotes the management of a sugar plantation, including not only the cultivation of the cane, but the various processes for the extraction of the sugar, together with the making of sugar-spirits. See RUM, SACCHARUM, and SUGAR.

To effect a design so comprehensive, it is necessary for a planter to understand every branch of the art precisely, and to use the utmost attention and caution both in the laying down and executing of his plans. It is therefore the duty of a good planter to inspect every part of his plantation with his own eyes; to place his provisions, stores, and utensils, in regular order, and in safe repositories; that by preserving them in perfection, all kinds of waste may be prevented.

But as negroes, cattle, mules, and horses, are as it were the nerves of a sugar-plantation, it is expedient to treat that subject with some accuracy.

[Of Negroes, Cattle, &c.] In the first place, then, as it is the interest of every planter to preserve his negroes in health and strength; so every act of cruelty is not less repugnant to the master's real profit, than it is contrary to the laws of humanity: and if a manager considers his own ease and his employer's interest, he will treat all negroes under his care with due benevolence; for good discipline is by no means inconsistent with humanity: on the contrary, it is evident from experience, that he who feeds his negroes well, proportions their labour to their age, sex, and strength, and treats them with kindness and good nature, will reap a much larger product, and with infinitely more ease and self-satisfaction, than the most cruel taskmaster, who starves his negroes, or chastises them with undue severity. Every planter then who wishes to grow rich with ease, must be a good economist; must feed his negroes with the most wholesome food, sufficient to preserve them in health and vigour. Common experience points out the methods by which a planter may preserve his people in health and strength. Some of his most fruitful land should be allotted to each negro in proportion to his family, and a sufficient portion of time allowed for the cultivation of it; but because such allotment cannot in long droughts produce enough for his comfortable support, it is the incumbent

Plantain
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Planter-
ship.

Martin on
Plantership.

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Planter-
ship.

duty of a good planter to have always his stores well filled with Guinea corn, yams, or eddoes, besides potatoes growing in regular succession: for plenty begets cheerfulness of heart, as well as strength of body; by which more work is effected in a day by the same hands than in a week when enervated by want and severity. Scanty meals may sustain life; but it is evident, that more is requisite to enable a negro or any other person to go through the necessary labours. He, therefore, who will reap plentifully, must plant great abundance of provisions as well as sugar-canes; and it is nature's economy so to fructify the soil by the growth of yams, plantains, and potatoes, as to yield better harvests of sugar, by that very means, than can be produced by many other arts of cultivation. Plantains are the principal support of all the negroes in Jamaica; and are also much cultivated, at great expence of manure, in Barbadoes; but ought not to be solely depended upon in climates subject to hurricanes. A celebrated planter and economist of the last mentioned island, who raised an immense fortune from very small beginnings only by planting, affirmed, that he fed constantly at least 300 negroes out of 12 acres of plantains. How that excellent produce came to be so long neglected in some of the islands it is hard to guess; but at present the neglect seems to be founded upon a vulgar error, that plantains cannot thrive in any other than low moist soils. In such places, no doubt, they flourish most luxuriantly; but yet they thrive and bear fruit abundantly on mountains and in marshes, and in the driest black mould upon marle or rocks, and even in sharp gravelly soils, as may be evinced by numberless instances.

However plenty of wholesome food may be conducive to health, there are also other means, equally necessary to strength and the longevity of negroes, well worth the planter's attention: and those are, to choose airy dry situations for their houses; and to observe frequently that they be kept clean, in good repair, and perfectly water-tight; for nastiness, and the inclemencies of weather, generate the most malignant diseases. If these houses are situated also in regular order, and at due distances, the spaces may at once prevent general devastations by fire, and furnish plenty of fruits and pot-herbs, to please an unvitiated palate, and to purify the blood. Thus then ought every planter to treat his negroes with tenderness and generosity, that they may be induced to love and obey him out of mere gratitude, and become real good beings by the imitation of his behaviour; and therefore a good planter, for his own ease and happiness, will be careful of setting a good example.

Having thus hinted the duties of a planter to his negroes, let the next care be of cattle, mules, and horses. The planters of Barbadoes (who are perhaps the most skilful of all others, and exact to a nicety in calculations of profit and loss), are, with respect to their cattle, the most remiss of any in all the islands; as if the carriage of canes to the mill, and of plantation-produce to the market, was not as essential as any other branch of planter-ship. At Barbadoes, in particular, the care of these animals is of more importance; because the soil, worn out by long culture, cannot yield any produce without plenty of dung. Some planters are nevertheless so ingeniously thrifty, as to carry their canes upon negroes' heads; acting in that respect diametrically opposite to

their own apparent interest, which cannot be served more effectually than by saving the labour of human hands, in all cases where the labour of brutes can be substituted; and for that end, no means of preserving those creatures in health and strength ought to be neglected.

The first care therefore is to provide plenty and variety of food. In crop-time, profusion of cane-tops may be had for the labour of carriage; but they will be more wholesome and nutritious if tedded like hay by the sun's heat, and sweated by laying them in heaps a few days before they are eaten. In this season of abundance, great ricks of cane-tops (the butt ends turned inwards) should be made in the most convenient corner of each field, to supply the want of pasturage and other food: and these are very wholesome if chopped into small parts, and mixed sometimes with common salt or sprinkled with melasses mixed with water: but yet the cattle require change of food to preserve them in strength; such as Guinea corn, and a variety of grass, which every soil produces with a little care in moist weather; and indeed this variety is found necessary in all climes.

But since that variety is not to be had during those severe droughts to which hot climates are liable, and much less in those small islands which cannot furnish large tracts of meadow-lands for hay, the only resource is the fodder of cane-tops or tedded Guinea-corn leaves; which are very nutritious, and may be preserved in perfection for more than a whole year, provided the tops or Guinea-corn are well tedded for three or four hot days as they lie spread in the field; and then, being tied into bundles or sheaves, must lie in the hot sun for three or four days more, when they may be fit to be put up into ricks. The best method of making them is in an oblong figure, about 30 feet in length, and 16 or 18 feet wide; seven feet high at the sides, and from thence sloping like the roof of an house, the ridge of which must be thatched very carefully; for the sides may be secured from wet by placing the bundles with the butts upwards towards the ridge, in courses, and lapping the upper over the lower course.

The best method of forming those ricks is to place the first course of bundles all over the base one way; the second course reversely; and so alternately till the rick be finished.

When cattle are to be fed with this fodder, it must be observed to take down the bundles from the top, at the west end of the rick, to the bottom; for all these ricks must stand east and west lengthwise, as well to secure them from being overturned by high winds, as for the convenience of preserving them from wet, which cannot be done when ricks are made round. By this husbandry, an herd of cattle may be kept in strength, either in severe droughts, or in wet seasons when grass is purgative; and thus the necessity or expence of large pastures may be totally saved. The hay-knife used in England for cutting hay, answers for cutting ricks of tops.

The method of tedding Guinea-corn to make a kind of hay, will require a little explanation here. When Guinea corn is planted in May, and to be cut down in July, in order to bear seed that year, that cutting, tedded properly, will make an excellent hay, which cattle prefer to meadow-hay. In like manner, after Guinea-corn has done bearing seed, the after crop will furnish a

Planter-
ship.

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Planter- great abundance of that kind of fodder which will keep
ship. well in ricks for two or three years.

The next care of a planter is to provide shade for his cattle; either by trees where they are fed in the heat of the day, if his soil requires not dung; or by building a flat shade over the pen where cattle are confined for making it. That such shades are essentially necessary to the well-being of all animals in hot weather, is apparent to every common observer, who cannot fail of seeing each creature forsaking the most luxuriant pastures in the heat of the day for the sake of shade; thus convincing the owners, by instinctive argument, that shade is almost as necessary to the well-being of the brute creatures as food. Yet, notwithstanding that demonstration from the unerring course of nature, throughout all our islands (except in a very few instances), these poor creatures are exposed to the scorching sun-beams without mercy. Such inhuman neglect is not always so much the effect of inattention as of a mistaken notion that shades are impeditmental to the making of much dung; but a flat shade, covered with cane-trash, may be so made as to let rain pass through it without admission of sun-beams. This will do for cattle; but mules, which are spirited creatures, and work themselves by draught into a foaming heat, should be put into a warm stable, until quite cool: for turning them loose to pasture when so hot, is probably the cause of their destruction by the glanders.

If the care of providing shade for brute creatures is so much the duty and interest of their owners, how much more is it agreeable to the laws of humanity to provide shade for human creatures travelling upon the high-roads in this hot climate? Nothing surely of so much beauty costs so little expence as planting cocoa-nut or spreading timber trees in avenues along the highways, if each proprietor of the lands adjoining hath any taste of elegance, or feeling for other men: but both those kinds of trees will yield also great profit to the proprietor, by furnishing him with timber, when perhaps not otherwise to be had; or with a delicious milk, fitted by nature to cool the effervescence of the blood in this hot region; and also to improve the spirits made from sugar to the delicacy and softness of arrack. Cocoa-nut and cabbage-trees are both very beautiful and shady, bearing round heads of great expansion, upon natural trunks or pillars of elegant proportion, and of such an height as to furnish a large shade, with a free circulation of air equally refreshing to man and beast.

The common objection of injury to canes by the roots of such trees growing on their borders, may be easily removed by digging a small trench between the canes and trees, which may intercept their roots, and oblige them to seek sustenance in the common road. Let it also be considered, besides the benefits above suggested, that the planter will thus beautify his estate to the resemblance of a most sumptuous garden. And probably that very beauty might not only render the islands more healthful to the inhabitants, by preserving

them from fevers kindled by the burning sun-beams, but also much more fruitful by making the weather more seasonable: for as, by cutting down all its woods, an hot country becomes more subject to excessive droughts; so, by replanting it in the manner above described, this inconvenience would probably be prevented.

Let then the planter be kind not only to his fellow-creatures but merciful to his beasts; giving them plenty and variety of wholesome food, clear water, cool shade, and a clean bed, bleeding them after a long course of hard labour, currying their hides from filth and ticks (A); affording them salt and other physic when necessary; protecting them from the slaying rope-lashes of a cruel driver (who needs no other instrument than a goad); proportioning their labour to their strength; and by every art rendering their work as easy as possible. The general management of planters is not, perhaps, more defective in any other respect than in this: for, by pairing the cattle unequally, and by the drivers ill conduct in writhing to the right and left, the poor creatures are fatigued by much needless labour. An horse ought therefore to be harnessed before them as a leader. This docile creature, by being led in a straight line, will soon learn to be an unerring guide, and the cattle will follow in the same direction with united strength, and consequently with more effect and less fatigue to each individual.

The Portuguese of Madeira, by their poverty and scantiness of pasture, breed the smallest kind of cattle; and yet one yoke of them will draw a much greater weight than a pair of our largest oxen, solely by an equal exertion of their joint strength. That equality or evenness of draught is preserved by boring gimblet holes through their horns, within two inches of the points, and running a thong of leather through those holes, so as to tie the horns of each pair at six inches distance from each other. By this ligature the pair of cattle are absolutely hindered from turning different ways, and draw in an even direction with united force. Thus it appears evidently from reason, as well as from experience, that the labour of our beasts may, by a little contrivance, be rendered more easy and effectual.

Of the Culture of various Soils. In the British sugar-colonies there is as great a variety of soils as in any country of Europe; some naturally very rich or fruitful, yielding a luxuriant product with little labour or culture. This fruitful soil is of three kinds: a loose hazel mould mixed with sand, like that of St Christopher's, and is the best in the known world for producing sugar in great quantity, and of the best quality. The brick mould of Jamaica is somewhat of the same nature, and next in value; and then the various mixtures of mould and gravel, to be found in veins or plates over all the other islands. When any of these soils are exhausted of their fertility by long and injudicious culture, they may be restored by any kind of dung well rotted; for these (B) warm soils cannot bear hot unrotten dung, without being laid fallow for a considerable

VOL. XV. Part I.

(A) One pound of native sulphur, a quart of lamp-oil, and the like quantity of hog's-lard, intimately mixed and made into an ointment, is a cure for the mange, lice, &c.

(B) These soils, which are naturally loose and upon waste, Mr Martin calls *hot soils*; and these, he says, have been

Planter-
ship.

able time after it. Another improvement is by sea-fand or sea-weed; or by digging in the cane-trash into steep lands, and by letting it lie to rot for some months. A third method is, by ploughing and laying it fallow; and the fourth method (the best of all), is by folding the fallows by sheep. But this can be practised only where there are extensive pastures; nor can the plough be employed where the soil abounds with large stones. In that case, however, the former method of digging in trash will be nearly as effectual, though more expensive, by hand-labour or hoe-ploughing.

The next best soil for producing good sugar is a mould upon clay, which if shallow requires much culture and good labour, or its produce will be small in quantity, though of a strong grain and bright colour, so as to yield most profit to the refiner of any sugar, except that produced from an hazel or gravelly soil, as before-mentioned. All the black-mould soils upon marle are generally fruitful, and will take any kind of dung; but yield not so strong or large-grained sugar. Marle, however, of a white, yellow, or blue colour, or rich mould from washes, or ashes of every kind, are excellent for every strong soil, as the chief ingredient in the compost of dung: either of them will do alone for stiff lands; but the yellow and chocolate marle are the most soapy, and the richest kind of manure (except fine mould) for all stiff lands. If these are well opened, pulverized by culture, and mixed with hot dung, or any kind of loose earth or marle, they will produce as plentifully as lighter soils: and all kinds of clay-foils, except that of a white colour, have these two advantages above the finest gravel soils, that they do not scorch soon by dry weather, and never grow weary of the same manure, as most other soils do.

The extraordinary hand-labour bestowed in making dung, may be saved by the art of caving, now in general use in England. Ten mules or horses, and two light tumbrils with broad wheels, and ten able negroes, may, by the common use of spades, shovels, and light mattocks, or grubbing hoes, make more dung than 60 able negroes can do in the present methods.

If marle lies upon rising ground, or in hillocks, as it often does, the pit is to be opened at the foot of the declivity; which being dug inwards, till the bank is three feet high, then it is to be *caved* thus. Dig an hollow space of 12 or 18 inches deep under the foot of the bank; then dig into each side of it another perpendicular cut of the same depth, and 18 inches wide from the top of the bank to the bottom: that being finished, make a small trench a foot or two from the brink of the bank; pour into it water till full; and when that is done, fill it again, till the water soaking downward makes the marle separate and fall down all at once. This may be repeated till the pit rises to 50 feet high; and then many hundreds of cart-loads of marle may be thrown down by four negroes in two hours; from whence it may be carted into cattle-pens or laid out upon lands, as occasion requires. Five or six negroes with spades or shovels will keep two or three tumbrils em-

ployed, according to the distance of cartage: and thus as much dung may be made by ten negro men as will dung richly at least 70 or 80 acres of land every year, and laid out also with the assistance of cattle-carts: An improvement highly worth every planter's consideration, when negroes and feeding them are so expensive; and this is no speculation, but has been confirmed by practice. In level lands, the same operation may be as effectual, provided the mouth of the pit be opened by gradual descent to any depth: but when marle is to be found on the sides of hills, the operation is less laborious for the horses. But if the surface of the marle-pits (as it often happens) be covered with clay or stiff soil, so that the water cannot quickly soak from the trench above; in that case, pieces of hard wood, made like piles, four feet long, and four inches square, pointed at one end, and secured at the other square head by an iron clamp, may be driven by heavy mauls into the trench, as so many wedges, which will make the caved part tumble down: but a skilful eye must watch the last operation, or the labourers may be buried or hurt.

But then clay-foils that are level, and subject to be drowned, or to retain water in stagnated pools, can never be made fruitful by any kind of manure, without being first well drained: for water lying upon any soil will most certainly transform it to a stiff unfruitful clay; as appears evidently by the bogs of Ireland, the fens of Lincoln and Cambridgeshire, and even by the ponds of Barbadoes situated in the deepest and lightest black mould; for that fine soil being washed into those ponds, becomes the stiffest black clay, not fit even for an ingredient in dung, until it has been laid dry, and exposed to the sun for a whole year: but when these bogs and fens are well drained, they become the most fruitful soils. Natural clay the celebrated Boerhaave thinks the fattest of all soils; but then it must be opened by culture, marle, or sandy manures. It is hard to conjecture how the opinion prevailed in the British plantations, that sandy gut-mould was most unfit for clay-foils, as being the means of binding them to the compactness of brick; whereas it is proved, from long experience, to be one of the best means of opening clay-foils, and rendering them abundantly fruitful. Brick is made of *clay alone*; no sand being used in it, farther than to sprinkle the board, on which it is moulded into shape. From repeated experience it appears, that a mixture of sand in gut-mould is the best of all manure for stiff and barren clay-lands; provided they be well drained, by throwing the whole soil into round ridges of 12 feet wide, with furrows of three feet wide between each ridge. And this is done with little more hand-labour than that of hoe-ploughing well in the common way. For if a piece of land be marked in lines at seven feet and a half distance from each other, and the labourers are set in to hoe-plough at the second line, hauling back each clod 12 inches; half the ridge, and near half the furrow, is made at the same time: and thus a piece of land may be round-ridged, and the furrows all made at once, by the common operation of hoe-ploughing, provided the digger drives his hoe up to the eye at every stroke. Hoe-ploughing

Planter-
ship.

been much injured in some of the islands by dung hastily made with marle: but if the sediment of lees were thrown into these pens, after being turned over, it would much improve the dung.

Platter-
Ship.

ploughing in clay-soils that have lain long under water, is indeed hard labour; but it will every year grow the lighter by being well-drained by round-ridging: and in the meanwhile the labour may be rendered much more easy by the plough conducted by the lines above described. As therefore sandy mould is the best manure for stiff clay; so, by parity of reason, confirmed by long experience, stiff clay is the best manure for sandy or chaffy soils.

The method of round-ridging before described, is, by several years experience, found the most essential improvement of flat clayey soils: and yet there are some who will prefer speculation to ocular demonstration, fancying that all kinds of ridges will carry off the mould in heavy rains. The fact is otherwise in clay-soils: and plain reason, without experience, vouches, that where great confluxes of water are divided into many small rills, the force is broken; and therefore less mould carried off the land. Another objection made to round-ridging is, that by digging much clay to form the sides of the ridge, the soil is impoverished: but this objection stands good only against those ridges which are raised too high, and made too broad; but if land is ridged in the manner before directed, that is, 12 feet broad, and not above six or eight inches higher in the middle than at the sides, the objection vanishes. Ridges were never proposed for light soils or steep lands; and even in flat soils upon loam they should be made with great caution, because *loam melts away by water*. But there are poachy lands of a white clay, even upon small descents, too retentive of water; these may certainly be improved much by ridges of 12 feet wide, as above described, without fear of washes.

But supposing, as the objection urges, that a little clay should be turned up at the sides of such ridges, can it not be manured somewhat more than the other parts with marle or sandy mould, so as to become equally good with any other part of the soil? And is not this well worth the labour, since round-ridging not only improves the soil by draining it to a surprising degree, but adds one-fifth part to the depth of the staple? And will not a ridge made a little rounding, throw off the water much better than a flat ridge?

The general maxim of not burning cane-trash (which may be called the *stubble of cane-lands*) upon any kind of soil, is surely a great mistake; as may be evinced by observing the contrary practice of the best husbandmen in England, where burn-baiting or bastard burn-baiting, is found by experience an admirable method of fertilizing cold, stiff, or clayey lands. It must indeed be a constant practice, not only for the sake of contributing to warm and divide the soil, but as the only effectual means of destroying pernicious insects, and weeds of various kinds, such as French weed, wild pease, and wild vines.

Soon after the disuse of burning trash upon our lands in the islands, the blast made its first appearance with incredible devastation: to revive that practice therefore seems to be the most obvious means of expelling it. It

may be presumed that the disuse of burning trash was founded upon the mistaken notion of burn-baiting, which is turning up a thick sod of very dry, light, and shallow soils, and burning the whole superficies or staple to ashes. This practice the writers upon husbandry condemn universally, and very justly: for though by this practice the land will produce two or three crops more plentifully than ever, yet the soil is blown away by the wind, and the substratum being generally an hungry gravel or chalk, can never be restored to fertility by the common arts of husbandry. But surely this has no resemblance to our superficial burning of the little trash we can spare from dung: and though this method of burn-baiting light and shallow soils be justly condemned, yet the best writers recommend that very practice in cold, moist, and heavy soils, as is observed above; and long experience justifies it.

Deep mould upon clay or loam being subject to the grub-worm (c), will not take any kind of dung, till perfectly rotten, except that of the sheep-fold; which is the best manure for all kinds of light soils, and is of all others the least expensive, as not requiring hand-labour. But the use of the fold is impracticable in any island not abounding with large savannas or sheep-pastures, as in Jamaica.

Those soils therefore which are subject to the grub, and must be fertilized by common dung, which is a proper nest for the mother-beetle to deposit its eggs, must be well impregnated with the brine of dissolved salt, after the dung is first cut up; two large hogheads of salt will make brine enough for a dung-pen of 50 feet square.

This cure for the grub is a late discovery; and which has been attended with success, so far as the experiment is made. But though it proves effectual to destroy that pernicious insect in plant-canes, it probably will not be sufficient to save rattoons, without a new application of salt in powder; because the first brine must be washed away by the time when rattoons spring up.

The planter who would save his rattoons from the grub ought therefore to cut off the heads of his stools with sharp hoes three inches below the surface of the soil, and then strew an handful of salt round each stool, and cover it up to a level with fine mould taken from the edges.

In soils where there is no grub, and the planter wishes to have very good rattoons, let him, as soon as his canes are cut, draw all the trash from the stools into the alternate spaces, if planted in that manner; or into the furrows, if his land be round-ridged; and then cut off the head of his stools with sharp hoes, as above directed. Experience has shown the advantage of this practice, and reason demonstrates the great benefit of the ratoon-sprouts rising from three inches below the surface, instead of superficial shoots which come to nothing, and only starve the strong sprouts. Besides, the stubs which are left upon the stools after the canes are cut, canker, and rot the stools; which is one reason why good rat-

(c) This pernicious insect is most apt to engender in dung made from mill-trash, which therefore never ought to be put into dung-compost or still-ponds; but after being burnt, the ashes will be as good as any other kind. Round-ridging, with manure of unwet ashes, sea-sand, or lime, or dry marle, kills the grub.

Platter-
Ship.

Planter-
ship.

toons are uncommon in soils long cultivated. Yet it is the opinion of some, that by hoe-ploughing and even dunging rattoons, the produce might be as good plant-canes, which would save the labour of holing and planting so often as planters commonly do.

Fallowing is of incredible advantage to every soil, not only by being divided into the minutest parts, but also by imbibing those vegetative powers with which the air is impregnated by the bountiful hand of Providence, whenever rain falls. What those powers are has been explained under the articles AGRICULTURE and PLANT; and experience evinces, that the tender vegetables of the earth are enervated more by the smallest shower of rain, than by all the water which human art can bestow. Let it therefore be a constant maxim of the planter, never to plant his ground until the soil is well mellowed by fallowing, even though he bestows upon it a due proportion of dung: we say a due proportion; for too much will force up rank canes, which never yield good sugar; and though some advantage may be reaped from the rattoons, yet it will be found by experience not to compensate the loss by the plants. In stony or steep soils, where the plough cannot be used, or where a sufficient strength of cattle cannot be supported for that purpose, hand-labour or hoe-ploughing must be substituted: but even in that case, much labour may be saved by spreading the dung according to the English husbandry, and digging it into the soil. To evince this truth, let any planter compute his negroes labour of distributing dung by baskets, and by spreading it with dung-forks; and then judge for himself by one single experiment which is the most profitable.

But if some planters are so devoted to the old custom of distributing dung by baskets instead of wheel-barrows in level ground, or hand-barrows in uneven land, by which three times the labour may be accomplished in the same time and by the same hands; let them at least save much of their hand-labour, by the following method of laying out dung, before the distribution by baskets.

In holing a piece of land, let a space be left after 80 holes from the first interval, and then the like space after 80 holes throughout the whole plat, which spaces must run exactly parallel to the intervals on the right and left of the holes. Into these spaces the dung may be carted, even before it be rotten (D), at the most leisure times, and covered with mould or cane-trash, to prevent exhalation; and in such quantity as will suffice only to dung a row of 40 holes, from the point opposite to each side of it. In the intervals at each side of the cane-piece, which are parallel to those spaces, there must be dung enough carted to manure a row of 40 holes, and covered in like manner.

By thus placing the dung or gut-mould, it is evident

Planter-
ship.

at the first sight, that the farthest distance cannot be above 40 holes in distributing the dung: and in case it be not sufficiently rotten for present use, it may be distributed even in dry weather, and covered by the bank; which will both prevent its spirit from exhalation, and occasion it to rot sooner, which is no small advantage. Moreover, by being thus laid out at the most leisure times, and covered with the banks, the dung will be more intimately mixed with the soil, and therefore continue to nourish the plant for a longer time than if laid as usual at the bottom of the holes. A farther advantage of thus distributing the dung, and covering it, results from the more expeditious planting the land after a short or sudden shower: for the labour of covering the dung, and uncovering it when the land is planted, however it may appear in speculation, is in practice a trifle; and besides all the other advantages arising by the distribution of dung from the spaces above described, this is not the least, that not a bank is trodden under foot. But it is evident, that by distributing the dung with baskets in the present method, the soil is much trampled under foot; and by that means, the very end of hoe-ploughing, or loosening the soil, is much defeated. In like manner, by the present method of hoe-ploughing, the same ill effect is produced; for as the negroes hoe-plough or dig the soil directly forward, so they must necessarily tread the ground as fast as they dig it: whereas by putting the labourers to dig sideways, no one puts a foot upon the soil after it is dug; and by lining the land before it is hoe-ploughed, each negro may have an equal share to dig. The only difficulty of hoe-ploughing sideways is in first setting the negroes to that work; but it may be done without loss of time when working in a contiguous field. Whether hoe-ploughing before or after the land be holed for canes is most eligible, experience must determine; but certainly both operations will be most effectual: and therefore it will be advisable (E), first to plough the soil where the land will admit the plough; and where it will not, to hoe-plough it with or without dung, as requisite; then let it lie fallow till perfectly mellowed; then hole and plant it; and instead of weeding in the usual manner, let the weeds in all the spaces be dug into the soil: but as this is not to be done so well with the hoe, it is submitted to future experience, whether the dexterous use of spades, as in England, will not answer the purpose much better, and with equal dispatch. But whatever method is preferred, most certain it is, that by loosening the soil in all the spaces between the young canes after being come up, their fibres will more easily expand on every side, and acquire more nutrition to invigorate their growth. But where the planter grudges this labour, by thinking it needless in a rich loose soil, he may dispatch more weeding-work by the Dutch hoe than by any other; which being fastened upon

(D) In order to make dung rot the sooner, much labour is bestowed in digging and turning it over by hoes: but two-thirds of that labour may be saved by the use of hay-knives; six of which, used dexterously, will cut up a pen in less time than 60 negroes can do by hoes: but hay-knives cannot be used where gritty mould is used in pens.

(E) Deep and loose soils may be ploughed with a small strength of cattle or mules: but stiff lands in hot climates require more strength of cattle than can be maintained in the small pastures of the planters; for if those strong soils are either too wet or too dry (as is generally the case), ploughing is impracticable.

upon the end of a stick, is pushed forward under the roots of the small weeds, in such a manner as to cut them up a little below the surface of the soil, and will do more execution at one shove than can be done at three strokes of the common hoe: but there is yet another practice of the horse-hoe plough, whereby all weeds growing in rows between beans and pease, are extirpated with incredible ease and expedition. It is a very simple machine, drawn by one or two horses, consisting of a pair of low wheels turning upon a common axis; from whence two square irons are let down at equal distances, and triangular hoes made at the ends, the points of the triangles being placed forward, and so fixed as to cut all weeds an inch below the surface, in the same manner as the Dutch garden hoe above-mentioned. By this machine a man and a boy, with two horses or mules, will clear perfectly all the spaces of a field of ten acres in two days, and may be of admirable use in all loose and dry soils in the sugar-islands: for while two horses or mules draw in the space before each other, the wheels pass on the outside of each row of canes, without doing the least injury, while the plough-holder attends to his business. In stiff soils which require draining, neither the horse-hoe plough nor the Dutch hoe can be proper; or any other instrument so effectual as the spade used in the manner above hinted, where the staple is deep.

But where the staple of land is shallow, care must be taken not to dig much below it, according to the universal opinion of all the best writers, supported by the experience of 100 years. Yet some good planters are fallen into the contrary practice, and dig up stiff clay far below the staple. This, Mr Martin says, was done in his own lands, during his absence, by injudiciously ploughing below the staple; and so injured the soil, that all the arts of culture for many years hardly retrieved its former fertility. Indeed, where the staple is shallow, upon a fat clay, the turning up a little of it at a time, from the bottom of the cane-holes, and mixing it with rich hot dung, made of marle, or sandy mould, which may take off its cohesive quality, will in due time, and by long fallow, convert it into good soil: but if stiff clay be turned up, without any such mixture, in large quantities, it will infallibly disappoint the operator's hopes: for though solid clay will moulder, by exposure, to a seeming fine earth, yet it will return to its primitive state very soon after being wet, and covered from the external air, if not divided, as above suggested.

After all, the common horse-hoeing plough drawn by two mules in a line before each other, or the hand-hoe in common use, will answer the purpose very well, where the lands are planted in Mr Tull's method; that is, where the spaces are equal to the land planted, in the following manner.

Suppose six feet planted in two rows of canes, and six feet of land left as a space unplanted; and so a whole piece of land, planted in alternate double rows (F), with equal spaces, may be hoe-ploughed with ease, as before hinted; and that at any time during the growth of canes, when it is most convenient to the planter, which is a

considerable advantage; and yet it is the least of all attending this method of culture: for, by leaving these spaces, the canes will have both more air and sun: by hoe-ploughing them, the roots of each double row will have large room for expansion, and consequently, by gaining more nutriment, will grow more luxuriantly: by these spaces the canes may be cleaned from the blast with much more ease and convenience; and will serve as proper beds to plant great corn, without the least injury to the canes; as well as to contain the trash taken off the land, where, by rotting, and being hoe-ploughed into the soil, it will wonderfully enrich it, and will fit it to be planted immediately after the canes in the neighbouring double rows are cut down. Besides all these admirable advantages of planting the land in alternate double rows with equal spaces, the canes, when at full age, may be easily stripped of their trash, and by that means the juice rendered so mature as to yield double the produce, and much better sugars than unstripped canes. This method of culture may be recommended for all kinds of soil: for as by this practice the rank luxuriant canes will be more matured, so the poor soils will be rendered more fruitful; and as the roots of the canes which expand into these spaces will be kept moist by being covered with rotten trash, so they must bear dry weather much longer in the burning soils. In those low lands which require draining by furrows, the alternate double rows and spaces must be made cross the ridges; by which means those spaces, being hoe-ploughed from the centre to the sides, will be always preserved in a proper state of roundness. By this method of planting, the canes may be so well ripened as to yield double the quantity of sugar of canes planted in the close manner: which saves half the labour of cartage, half the time of grinding and boiling, and half the fuel, besides yielding finer sugar.

Yet, how well soever the method of planting in single or double alternate rows has succeeded in the loose and stiff soils, experience has shown that it is a wrong practice in stiff lands that are thrown into round or flat ridges: for these being most apt to crack, the sun-beams penetrate soon to the cane-roots, stop their growth, and have an ill influence upon the sugar. It is therefore advisable to plant such lands full, but in large holes, of 4 feet, by 5 feet towards the banks: after the plant-canes are cut, to dig out one, and leave two rows standing, hoe-ploughing the spaces after turning all the trash into furrows till almost rotten: for if the trash is drawn upon the hoe-ploughed spaces, they will hardly ever moulder, at least not till the trash is quite rotten. This is an infallible proof from experience of how little advantage trash is to the soil, unless it be in great droughts, to keep out the intense sun-beams: for, in all other respects, it prevents that joint operation of the sun and air in mouldering and fructifying the soil, as has been proved by repeated experiments.

But in flat stiff soils that are properly drained by round-ridging, no culture prevents cracking so effectually as hoe-ploughing into them a quantity of loose marle, of which that of a chocolate or of a yellow colour is best.

(F) In stiff lands, the single alternate rows of four feet distance, as preventive of much labour in weeding, are found best; and also yield more sugar by the acre; and are less apt to be affected by drought.

Planter-
ship.

best; and it will be still much better, by lying upon the land, in small heaps, or in cane-holes, for some time, to imbibe the vegetative powers of the air before it is intimately mixed with the soil.

As to the manner of planting canes, the general practice of allowing four feet by five to an hole, and two fresh (G) plants, is found by common experience to be right and good in alternate rows. But the following precautions are necessary to be observed. First, let all the cane-rows run east and west, that the trade-wind may pass freely through them; because air and sunshine are as conducive to the growth and maturation of sugar-canes as of any other vegetable. Secondly, let not any accession of mould be drawn into hills round the young canes, except where water stagnates (H); because the fibres which run horizontally, and near the surface, are much broken and spoiled by that practice. Thirdly, let the sugar-canes be cut at their full maturity; which, in a dry loose soil, is generally at the end of 14 or 15 months after being planted; but in cold clay-soils, not till 16 or 17 months. Fourthly, as the cane-rows run east and west in as proper a direction as possible for cartage to the sugar work, so canes must be cut the contrary way if the planter expects any great produce from his ratoon: for by beginning to cut canes at the part of his field most remote from the works, the carts cannot often pass over the same tract, and consequently the cane-stools cannot be injured, more especially if he takes due care to cut the canes very close to their roots; for, by leaving a long stub (which must perish) the cane-stools are much injured. It may be objected to the practice of the cutting canes transversely to the rows, that the negroes labour will not be so equally divided: but let every man consider both sides of the question, and be determined by his own experience; and then he will be convinced, that it matters very little which way he cuts straight standing canes; but in cases where the sugar-canes lean, or are lodged by preceding high winds, it is a point of great importance to place the labourers so as to cut the canes first at the roots, and then, drawing them, cut off the tops: for thus by two strokes each cane will be cut; and twice the quantity cut in the same time, and by the same hands, more than by cutting in any other direction. In round ridged land, it is proper to cut canes in the same direction of the ridges, throwing the tops and trash into the furrows to render the cartage easy, and to preserve the ridges in their proper form.

It is almost needless to suggest the expediency of planning the cane-pieces of a plantation in exact squares, so that the intervals may intersect at right angles; since such regularity is not only more beautiful, more safe in case of accidental fires, and a better disposition of the whole for dividing and planting one third or fourth part of a plantation every year, but also much easier guarded by a few watchmen: for one of these walking in a line

Plantin,
Planting.

from east to west, and the other from north to south, look through every avenue, where the most subtle thief cannot escape the watchful eye. And if the intervals surrounding the boundary of a regular plantation be made 24 feet wide, the proprietor will receive ample recompense for so much land, by the security of his canes from fires kindled in the neighbourhood, and by planting all that land in plantain-trees, which may at once yield food and shade to the watchmen, who by that means can have no excuse for absence from their proper stations. But as fuel grows very scarce in most of our islands, it is also expedient to plant a logwood or flower-fence in all the boundaries of every plantation, which, being cut every year, will furnish good store of faggots. Logwood makes the strongest and quickest of all fences, and agrees with every soil: the cuttings make excellent oven-fuel.

So much for the general operations of planter-ship, according to the approved directions of Mr Martin. For the particular cultivation of the sugar-canes, the extraction of the sugar, and the distillation of rum, see the articles SACCHARUM, SUGAR, and RUM.

PLANTIN (Christopher), a celebrated printer, was born near Tours in 1533, and bred to an art which he carried to the highest degree of perfection. He went and settled at Antwerp; and there erected a printing-office, which was considered not only as the chief ornament of the town, but as one of the most extraordinary edifices in Europe. A great number of ancient authors were printed here; and these editions were valued not only for the beauty of the characters, but also for the correctness of the text, with regard to which Plantin was so very nice, that he procured the most learned men to be correctors of his press. He got immense riches by his profession; which, however, he did not hoard up, but spent like a gentleman. He died in 1598, aged 65 years; and left a most sumptuous and valuable library to his grandson Balthazar.

PLANTING, in agriculture and gardening, is setting a tree or plant, taken from its proper place, in a new hole or pit; throwing fresh earth over its root, and filling up the hole to the level of the surface of the ground.

The first thing in planting is to prepare the ground before the trees or plants are taken out of the earth, that they may remain out of the ground as short a time as possible; and the next is, to take up the trees or plants, in order to their being transplanted. In taking up the trees, carefully dig away the earth round the roots, so as to come at their several parts to cut them off; for if they are torn out of the ground without care, the roots will be broken and bruised, to the great injury of the trees. When you have taken them up, the next thing is to prepare them for planting by pruning the roots and heads. And first, as to the roots; all the small fibres are to be cut off, as near to the place from whence they

(G) It is an odd fancy that stale plants grow best, when both reason and experience vouch that the most succulent plants are best: one good plant in the centre of a large hole is sufficient when the land is full holed.

(H) The stagnation of water in pools (usual in stiff level lands) is the most injurious circumstance attending it; for that, by long duration, will convert the finest mould into stiff clay. The proprietor of such a soil must therefore grudge no labour to drain it well; and yet by such easy gradation as to prevent the mould from being washed away by great floods, in case the under stratum be a loam.

Planting. they are produced as may be, except they are to be replanted immediately after they are taken up. Then prune off all the bruised or broken roots, all such as are irregular and cross each other, and all downright roots, especially in fruit-trees: shorten the larger roots in proportion to the age, the strength, and nature of the tree; observing that the walnut, mulberry, and some other tender-rooted kinds should not be pruned so close as the more hardy sorts of fruit and forest trees: in young fruit-trees, such as pears, apples, plums, peaches, &c. that are one year old from the time of their budding or grafting, the roots may be left only about eight or nine inches long; but in older trees, they must be left of a much greater length: but this is only to be understood of the larger roots; for the small ones must be chiefly cut quite out, or pruned very short. The next thing is the pruning of their heads, which must be differently performed in different trees; and the design of the trees must also be considered. Thus, if they are designed for walls or espaliers, it is best to plant them with the greatest part of their heads, which should remain on till they begin to shoot in the spring, when they must be cut down to five or six eyes, at the same time taking care not to disturb the roots. But if the trees are designed for standards, you should prune off all the small branches close to the place where they are produced, as also the irregular ones which cross each other; and after having displaced these branches, you should also cut off all such parts of branches as have by any accident been broken or wounded; but by no means cut off the main leading shoots which are necessary to attract the sap from the root, and thereby promote the growth of the tree. Having thus prepared the trees for planting, you must now proceed to place them in the earth: but first, if the trees have been long out of the ground, so that the fibres of the roots are dried, place them eight or ten hours in water, before they are planted, with their heads erect, and the roots only immersed therein; which will swell the dried vessels of the roots, and prepare them to imbibe nourishment from the earth. In planting them, great regard should be had to the nature of the soil: for if that be cold and moist, the trees should be planted very shallow; and if it be a hard rock or gravel, it will be better to raise a hill of earth where each tree is to be planted, than to dig into the rock or gravel, and fill it up with earth, as is too often practised, by which means the trees are planted as it were in a tub, and have but little room to extend their roots. The next thing to be observed is, to place the trees in the hole in such a manner that the roots may be about the same depth in the ground as before they were taken up; then break the earth fine with a spade, and scatter it into the hole, so that it may fall in between every root, that there may be no hollows in the earth: then having filled up the hole, gently tread down the earth with your feet, but do not make it too hard; which is a great fault, especially if the ground be strong or wet. Having thus planted the trees, they should be fastened to stakes driven into the ground to prevent their being displaced by the wind, and some mulch laid upon the surface of the ground about their roots; as to such as are planted against walls, their roots should be placed about five or six inches from the wall, to which their heads should be nailed to prevent their being blown up by the wind. The seasons for planting are various, according to the diffe-

rent sorts of trees, or the soil in which they are planted. For the trees whose leaves fall off in winter, the best time is the beginning of October, provided the soil be dry; but if it be a very wet soil, it is better to defer it till the latter end of February, or the beginning of March: and for many kinds of evergreens, the beginning of April is by far the best season; though they may be safely removed at midsummer, provided they are not to be carried very far; but should always make choice of a cloudy wet season.

In the second volume of the papers, &c. of the Bath Society there is a letter on planting waste grounds. The gentleman who writes it informs us, that in the county of Norfolk, where he resides, there were about 60 or 70 years ago vast tracts of uncultivated ground, which were then thought totally barren. "The western parts of it (says he) abounded with sand of so light a texture, that they were carried about by every wind; and in many places the sands were so loose that no grass could grow upon them. Art and industry, however, have now so altered the face of this once Arabian desert, that it wears a very different appearance. Most of these tracts are either planted or rendered very good corn-land and sheep-walks.

"About 30 years since, the sides of many of our little sand-hills were sown with the seeds of French furze, and when a wet season followed, they succeeded very well, and grew so fast, that once in three or four years they are cut for fuel, and sell at a good price at Thetford, Brandon, Herling, Swaffham, and places adjacent. This excited some public spirited gentlemen, among whom was the late Mr Buxton of Shadwell-Lodge, near Thetford, to attempt the planting of Scotch and spruce firs, and other hardy forest-trees. At first they found some difficulty from the extreme looseness of the sand. But as there is in all this part of the country fine white and yellow marle, at about three feet depth below the sand, they very judiciously thought that incorporating it with the sand in the holes where their young trees were planted, would insure success; nor were they disappointed. The method succeeded beyond expectation; the plantations thrived exceedingly, and the roots soon reached below the sand, after which they were out of danger. This excited them to further attempts.

"On the spots where they intended to raise new plantations from seeds and acorns, they laid on a thick coat of marle and clay, which after being rough spread, and lying a winter in that state, was made fine, and ploughed in just before planting. By these means the soil became fixed, and in a little time covered with grass and herbage; so that there are now vast plantations of firs, oak, and forest-trees, in the most healthy and vigorous state, where within my memory ten acres of land would not maintain a single sheep three months.

"But the benefit of plantations, whether of shrubs, copse, or trees, is not confined to the immediate advantage, or even the future value of the wood. By annually shedding a great number of leaves, which the winds disperse, and the rains wash into the soil, it is considerably improved; and whenever such copses have been stubbed up, the ground (however unfruitful before planting) has thereby been so enriched as to bear excellent crops for many years, without the additional help of manure. How much land-owners are interested in planting waste or barren spots I need not mention; and no-

Planting.

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Planting
Plashing.

thing but a degree of indolence or ignorance unpardonable in this enlightened age could induce them to neglect it.

"Nature has furnished us with plants, trees, and shrubs, adapted to almost every soil and situation; and as the laws of vegetation are now much better understood than formerly, it is a reproach to those whose practice does not keep pace with their knowledge in making the best use of her bounty. Let no man repine and say *the land is barren*; for those spots which appear to be so, owe that appearance to human negligence. Industry and art might soon render an eighth part of this kingdom nearly as valuable as the rest, which now remains in a state unprofitable to the owners, and disgraceful to the community."

Reverse PLANTING, a method of planting in which the natural position of the plant or shoot is inverted; the branches being set into the earth, and the root reared into the air. Dr Agricola mentions this monstrous method of planting, which he found to succeed very well in most or all sorts of fruit-trees, timber-trees, &c. Bradley affirms, that he has seen a lime-tree in Holland growing with its first roots in the air, which had shot out branches in great plenty, at the same time that its first branches produced roots and fed the tree. Mr Fairchild of Hoxton has practised the same with us, and gives the following directions for performing it: Make choice of a young tree of one shoot, of alder, elm, willow, or any other tree that easily takes root by laying; bend the shoot gently down into the earth, and so let it remain until it has taken root. Then dig about the first root, and raise it gently out of the ground, till the stem be nearly upright, and stake it up. Then prune the roots, now erected in the air, from the bruises and wounds they received in being dug up; and anoint the pruned parts with a composition of two ounces of turpentine, four ounces of tallow, and four ounces of bees wax, melted together, and applied pretty warm. Afterwards prune off all the buds or shoots that are upon the stem, and dress the wounds with the same composition, to prevent any collateral shootings, that might spoil the beauty of the stem.

PLANUDES (Maximus), a Greek monk of Constantinople, towards the end of the 14th century, who published a collection of epigrams intitled *Anthologia*; a Greek translation of Ovid's *Metamorphoses*; a *Life of Æsop*, which is rather a romance than a history; and some other works. We know nothing more of him, than that he suffered some persecution on account of his attachment to the Latin church.

PLASHING of HEDGES, is an operation thought by some persons to promote the growth and continuance of old hedges; but whether this fact be so or not will admit of some dispute. See *HEDGES*, n° 29, 37, &c.

It is performed in this manner: The old stubs must be cut off, &c. within two or three inches of the ground; and the best and longest of the middle-sized shoots must be left to lay down. Some of the strongest of these must also be left to answer the purpose of stakes. These are to be cut off to the height at which the hedge is intended to be left; and they are to stand at ten feet distance one from another: when there are not proper shoots for these at the due distances, their places must be supplied with common stakes of dead wood. The

hedge is to be first thinned, by cutting away all but those shoots which are intended to be used either as stakes, or the other work of the plashing: the ditch is to be cleaned out with the spade; and it must be now dug as at first, with sloping sides each way; and when there is any cavity on the bank on which the hedge grows, or the earth has been washed away from the roots of the shrubs, it is to be made good by facing it, as they express it, with the mould dug from the upper part of the ditch: all the rest of the earth dug out of the ditch is to be laid upon the top of the bank: and the owner should look carefully into it that this be done; for the workmen, to spare themselves trouble, are apt to throw as much as they can upon the face of the bank; which being by this means overloaded, is soon washed off into the ditch again, and a very great part of the work undone; whereas what is laid on the top of the bank always remains there, and makes a good fence of an indifferent hedge.

In the plashing the quick, two extremes are to be avoided; these are, the laying it too low, and the laying it too thick. The latter makes the sap run all into the shoots, and leaves the plashes without sufficient nourishment; which, with the thickness of the hedge, finally kills them. The other extreme of laying them too high, is equally to be avoided; for this carries up all the nourishment into the plashes, and so makes the shoots small and weak at the bottom, and consequently the hedge thin. This is a common error in the north of England. The best hedges made anywhere in England are those in Hertfordshire; for they are plashed in a middle way between the two extremes, and the cattle are by that prevented both from cropping the young shoots, and from going through; and a new and vigorous hedge soon forms itself.

When the shoot is bent down that is intended to be plashed, it must be cut half way through with the bill: the cut must be given sloping, somewhat downwards, and then it is to be wound about the stakes, and after this its superfluous branches are to be cut off as they stand out at the sides of the hedge. If for the first year or two, the field where a new hedge is made can be ploughed, it will thrive the better for it; but if the stubs are very old, it is best to cut them quite down, and to secure them with good dead hedges on both sides, till the shoots are grown up from them strong enough to plash; and wherever void spaces are seen, new sets are to be planted to fill them up. A new hedge raised from sets in the common way, generally requires plashing in about eight or nine years after.

PLASSEY, is a grove near the city of Muxadab in India, famous for a battle fought between the English under Lord Clive and the native Hindoos under the Nabob Surajah Dowlah. The British army consisted of about 3200 men, of whom the Europeans did not exceed 900; while that of the Nabob consisted of 50,000 foot, and 12,000 horse. Notwithstanding this great disproportion, however, Lord Clive effectually routed the Nabob and his forces, with the loss of 3 Europeans and 26 Seapoys killed, and 5 Europeans and 40 Seapoys wounded. The Nabob's loss was estimated at about 200 men, besides oxen and elephants. See *CLIVE*.

PLASTER, or *EMPLASTER*, in pharmacy, an external application of a harder consistence than an ointment;

Plaster. ment; to be spread, according to the different circumstances of the wound, place, or patient, either upon linen or leather. See PHARMACY, n° 613—635.

PLASTER, or *Plaisier*, in building, a composition of lime, sometimes with sand, &c. to parget, or cover the nudities of a building. See PARGETING and STUCCO.

PLASTER of Paris, a preparation of several species of gypsum dug near Mount Maitre, a village in the neighbourhood of Paris; whence the name. See ALABASTER, GYPSUM, and CHEMISTRY, n° 635, &c.

The best sort is hard, white, shining, and marbly; known by the name of *plaster-stone* or *parget of Mount Maitre*. It will neither give fire with steel, nor ferment with aquafortis; but very freely and readily calcines in the fire into a fine plaster, the use of which in building and casting statues is well known.

The method of representing a face truly in plaster of Paris is this: The person whose figure is designed is laid on his back, with any convenient thing to keep off the hair. Into each nostril is conveyed a conical piece of stiff paper, open at both ends, to allow of respiration. These tubes being anointed with oil, are supported by the hand of an assistant; then the face is lightly oiled over, and the eyes being kept shut, alabaster fresh calcined, and tempered to a thinish consistence with water, is by spoonfuls nimble thrown all over the face, till it lies near the thickness of an inch. This matter grows sensibly hot, and in about a quarter of an hour hardens into a kind of stony concretion; which being gently taken off, represents, on its concave surface, the minutest part of the original face. In this a head of good clay may be moulded, and therein the eyes are to be opened, and other necessary amendments made. This second face being anointed with oil, a second mould of calcined alabaster is made, consisting of two parts joined lengthwise along the ridge of the nose; and herein may be cast, with the same matter, a face extremely like the original.

If finely powdered alabaster, or plaster of Paris, be put into a basin over a fire, it will, when hot, assume the appearance of a fluid, by rolling in waves, yielding to the touch, steaming, &c. all which properties it again loses on the departure of the heat; and being thrown upon paper, will not at all wet it, but immediately discover itself to be as motionless as before it was set over the fire; whereby it appears, that a heap of such little bodies, as are neither spherical nor otherwise regularly shaped, nor small enough to be below the discernment of the eye, may, without fusion, be made fluid, barely by a sufficiently strong and various agitation of the particles which compose it; and moreover lose its fluidity immediately upon the cessation thereof.

Two or three spoonfuls of burnt alabaster, mixed up thin with water, in a short time coagulate, at the bottom of a vessel full of water, into a hard lump, notwithstanding the water that surrounded it. Artificers observe, that the coagulating property of burnt alabaster will be very much impaired or lost, if the powder be kept too long, especially if in the open air, before it is made use of; and when it hath been once tempered with water, and suffered to grow hard, they cannot, by any burning or powdering of it again, make it serviceable for their purpose as before.

VOL. XV. Part I.

This matter, when wrought into vessels, &c. is still of so loose and spongy a texture, that the air has easy passage through it. Mr Boyle gives an account, among his experiments with the air-pump, of his preparing a tube of this plaster, closed at one end and open at the other; and on applying the open end to the cement, as is usually done with the receivers, it was found utterly impossible to exhaust all the air out of it; for fresh air from without pressed in as fast as the other, or internal air, was exhausted, though the sides of the tube were of a considerable thickness. A tube of iron was then put on the engine; so that being filled with water, the tube of plaster of Paris was covered with it; and on using the pump, it was immediately seen, that the water passed through into it as easily as the air had done, when that was the ambient fluid. After this, trying it with Venice turpentine instead of water, the thing succeeded very well; and the tube might be perfectly exhausted, and would remain in that state several hours. After this, on pouring some hot oil upon the turpentine, the case was much altered; for the turpentine melting with this, that became a thinner fluid, and in this state capable of passing like water into the pores of the plaster. On taking away the tube after this, it was remarkable that the turpentine, which had pervaded and filled its pores, rendered it transparent, in the manner that water gives transparency to that singular stone called *oculus mundi*. In this manner, the weight of air, under proper management, will be capable of making several sorts of glues penetrate plaster of Paris; and not only this, but baked earth, wood, and all other bodies, porous enough to admit water on this occasion.

Plaster of Paris is used as a manure in Pennsylvania, as we find mentioned in a letter from a gentleman in that country inserted in the 5th volume of the Bath Society Papers, and which we shall insert here for the satisfaction and information of our agricultural readers. "The best kind is imported from hills in the vicinity of Paris: it is brought down the Seine, and exported from Havre de Grace. I am informed there are large beds of it in the Bay of Fundy, some of which I have seen nearly as good as that from France; nevertheless several cargoes brought from thence to Philadelphia have been used without effect. It is probable this was taken from the top of the ground, and by the influence of the sun and atmosphere dispossessed of the qualities necessary for the purposes of vegetation. The lumps composed of flat shining specula are preferred to those which are formed of round particles like sand: the simple method of finding out the quality is to pulverize some, and put it dry into an iron pot over the fire, when that which is good will soon boil, and great quantities of the fixed air escape by ebullition. It is pulverized by first putting it in a stamping-mill. The finer its pulverization the better, as it will thereby be more generally diffused.

"It is best to sow it in a wet day. The most approved quantity for grass is six bushels per acre. No art is required in sowing it more than making the distribution as equal as possible on the sward of grass. It operates altogether as a top manure, and therefore should not be put on in the spring until the principal frosts are over and vegetation hath begun. The general time for sowing with us is in April, May, June, July, August, and even as late as September. Its effects will generally

Plaster
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Plastic.

rally appear in 10 or 15 days; after which the growth of the grafs will be fo great as to produce a large burden at the end of fix weeks after fowing.

"It must be fown on dry land, not fubject to be overflown. I have fown it on fand, loam, and clay, and it is difficult to fay on which it has beft answered, although the effect is fooner vifible on fand. It has been ufed as a manure in this ftate for upwards of twelve years. Its duration may, from the beft information I can collect, be eftimated from feven to twelve years; for, like other manure, its continuance very much depends on the nature of the foil on which it is placed.

"One of my neighbours fowed fome of his grafs ground fix years ago, another four years ago; a great part of my own farm was fown in May 1788. We regularly mow two crops, and pasture in autumn; no appearance of failure, the prefent crop being full as good as any preceding. I have this feafon mowed fifty acres of red clover, timothy grafs, white clover, &c. which was plastered laft May, July, and September: many who faw the grafs eftimated the produce at two tons per acre, but I calculate the two crops at three tons. Several ftripes were left in the different fields without plaster; thefe were in a meafure unproductive, being fcarce worth mowing. In April 1788, I covered a piece of grafs land upwards of two inches thick with barn manure; in the fame worn-out field I fowed plaster, to contraft it with the dung. I mowed the dunged and plastered land twice laft year and once this; in every crop the plaster has produced the moft. You will remember, in all experiments with clover, to mix about one-third timothy grafs feed; it is of great advantage in ferving as a fupport for the clover; it very much facilitates the curing of clover, and when cured is a fuperior fodder. The plaster operates equally as well on the other graffes as on clover. Its effect is faid to be good on wheat, if fown in the fpring; but I cannot fay this from experience. On Indian corn I know its operation to be great; we ufe it at the rate of a table-foopful for a hill, put in immediately after dreffing.

"From fome accurate experiments laft year made and reported to our Agricultural Society, it appears that nine bufhels of additional corn per acre were produced by this method of ufig plaster."

PLASTERING. See PARGETTING.

PLASTIC, denotes a thing endowed with a formative power, or a faculty of forming or fashioning a mafs of matter after the likenefs of a living being.

PLASTIC-Nature, a certain power by which, as an instrument, many philofophers, both ancient and modern, have fuppofed the great motions in the corporeal world, and the various proceffes of generation and corruption, to be perpetually carried on.

Among the philofophers of Greece, fuch a power was almoft univerfally admitted. It feems, indeed, to have been rejected only by the followers of Democritus and Epicurus, who talk as if they had thought gravity effential to matter, and the fortuitous motion of atoms, which they held to have been from eternity, the fource not only of all the regular motions in the univerfe, but alfo of the organization of all corporeal fystems, and even of sensation and intellection, in brutes and in men. It is needlefs to fay, that thofe men, whatever they might profefs, were in reality atheifts; and Democritus, it is univerfally known, avowed his atheifm.

Plastic.

The greater part of the philofophers who held the exiftence of a plastic nature, confidered it not as an agent in the ftrict fenfe of the word, but merely as an instrument in the hand of the Deity; though even among them there were fome who held no fuperior power, and were of courfe as grofs atheifts as Democritus himfelf. Such was *Strato* of *Lampfacus*. This man was originally of the peripatetic fchool, over which he prefided many years, with no fmall degree of reputation for learning and eloquence. He was the firft and chief affertor of what has been termed *Hylozoic atheifm*: a fystem which admits of no power fuperior to a certain natural or plastic life, effential, ingenerable, and incorruptible, inherent in matter, but without fenfe and confcioufnefs. That fuch was his doctrine we learn from *Cicero*, who makes *Velleius* the Epicurean fay, "Nec audiendus *Strato* qui *Physicus* appellatur, qui omnem vim divinam in Natura fitam effe cenfet, quæ caufas gignendi, augendi, minuendi habeat, fed careat omni fenfu &c." That *Strato*, in admitting this plastic principle, differed widely from *Democritus*, is apparent from the following account of him by the fame author: "*Strato Lampfacenus* negat opera deorum fe uti ad fabricandum mundum, quæcunque fint docet omnia effe effecta natura, nec ut ille, qui afperis, et levibus, et hamatis uncinatifque corporibus concreta hæc effe dicat, interjecto inani; fomnia cenfet hæc effe *Democriti*, non docentis fed optantis &c."

That the rough and fmoother, and hooked and crooked, atoms of *Democritus*, were indeed dreams and dotages, is a pofition which no man will controvert; but furely *Strato* was himfelf as great a dreamer when he made fenfation and intelligence refult from a certain plastic or fpermatic life in matter, which is itfelf devoid of fenfe and confcioufnefs. It is, indeed, inconceivable, to ufe the emphatic language of *Cudworth*, "how any one in his fenfes fhould admit fuch a monftrous paradox as this, that every atom of duft has in itfelf as much wifdom as the greateft politician and moft profound philofopher, and yet is neither confcious nor intelligent!" It is to be obferved of *Strato* likewise, that though he attributed a certain kind of life to matter, he by no means allowed of one common life as ruling over the whole material univerfe. He fuppofed the feveral parts of matter to have fo many feveral plastic lives of their own, and feems to have attributed fomething to chance in the production and prefervation of the mundane fystem.

In denying the exiftence of a God, perpetually directing his plastic principle, and in fuppofing as many of thefe principles as there are atoms of matter, *Strato* deviated far from the doctrine of *Aristotle*. The great founder of the peripatetic fchool, as well as his apoftate difciple, taught that mundane things are not effected by fortuitous mechanifm, but by fuch a nature as acts regularly and artificially for ends; yet he never confiders this nature as the higheft principle, or fupreme Numen, but as fubordinate to a perfect mind or intellect; and he exprefly affirms, that "mind, together with nature, formed or fashioned this univerfe." He evidently confiders mind as the principal and intelligent agent, and nature as the fubfervient and executive instrument. Indeed, we are ftrongly inclined to adopt the opinion of the learned *Mosheim*, who thinks that by nature *Aristotle* meant nothing more than that *βίωσις ψυχική*, or animal heat, to which he attributes immortality, and of which he exprefly fays that all things are full.

† De Natura
Deorum, lib.
i. cap. 13.

§ Acad.
Quæft. lib.
iv. cap. 38.

† Cud. Int.
Syst. ed.
Nofte im.
lib. i. cap. 38.

† De Gene-
ratione A-
nimal. lib.
this iii. cap. 15.

lastic. this as it may, he always joins God and nature together, and affirms that they do nothing in vain. The same doctrine was taught before him by Plato, who affirms that "nature, together with reason, and according to it, orders all things." It must not, however, be concealed, that Plato seems to have attributed intelligence to the principle by which he supposed the world to be animated; for Chalcidius, commenting on the Timæus †, thus expresses himself: "Hæc est illa rationalis anima mundi, quæ gemina juxta meliorem naturam veneratione tutelam præbet inferioribus, divinis dispositionibus obsequens, providentiam nativis impertiens, æternorum similitudine propter cognitionem beata." — De Dog- Apuleius, too, tells us ‖, "Illam cœlestem animam, fontem animarum omnium, optimam virtutem esse generatricem, subferviri etiam Fabricatori Deo, et præsto esse ad omnia inventa ejus." Plato pronunciat.

This doctrine of Plato has been adopted by many moderns of great eminence both for genius and for learning. The celebrated Berkeley bishop of Cloyne, after giving the view of Plato's *anima mundi*, which the reader will find in our article MOTION, n° 10, thus recommends the study of his philosophy *: "If that philosopher himself was not read only, but studied also with care, and made his own interpreter, I believe the prejudice that now lies against him would soon wear off, or be even converted into high esteem, for those exalted notions, and fine hints, that sparkle and shine throughout his writings; which seem to contain not only the most valuable learning of Athens and Greece, but also a treasure of the most remote traditions and early science of the east." Cudworth, and the learned author of *Ancient Metaphysics*, are likewise strenuous advocates of the Aristotelian doctrine of a plastic nature diffused through the material world; (see METAPHYSICS, n° 200, 201, 202.): and a notion very similar has lately occurred to a writer who does not appear to have borrowed it either from the *Lycæum* or the *Academy*.

This writer is Mr Young, of whose *active substance*, and its agency in moving bodies, some account has been given elsewhere, (see MOTION). As a mere unconscious agent, *immaterial*, and, as he expresses himself, *immental*, it bears a striking resemblance to the *plastic nature* or *vegetable life* of Cudworth: but the author holds it to be not only the principle of motion, but also the *basis* or *substratum* of matter itself; in the production of which, by certain motions, it may be said to be more strictly *plastic* than the *hylarchical* principle, or *vis genitrix*, of any other philosopher with whose writings we have any acquaintance. Though this opinion be singular, yet as its author is evidently a man who thinks for himself, unwayed by the authority of celebrated names, and as one great part of the utility of such works as ours consists in their serving as indexes to science and literature, we shall lay before our readers a short abstract of the reasonings by which Mr Young endeavours to support his hypothesis, and we shall take the liberty of remarking upon those reasonings as we proceed.

The author, after a short introduction, enters upon his work ‡, in a chapter intitled, *Analysis of Matter in general*. In that chapter there is little novelty. He treats, as others have done, of primary and secondary qualities, and adheres too closely to the language of Locke, when

he says, that "the nature of bodies signifies the aggregate of all those *ideas* with which they furnish us, and by which they are made known." To say the best of it, this sentence is inaccurately expressed. An aggregate of *ideas* may be occasioned by the impulse of bodies on the organs of sense, but the effect of impulse cannot be that which impels. We should not have made this remark, which may perhaps be deemed captious, were we not persuaded that the vague and inaccurate use of terms is the source of those mistakes into which, we cannot help thinking, that the very ingenious author has sometimes fallen. Having justly observed, that we know nothing directly of bodies but their qualities, he proceeds to investigate the nature of solidity.

"Solidity (he says) is the quality of body which principally requires our notice. It is that which fills extension, and which resists other solids, occupying the place which it occupies; thus making extension and figure real, and different from mere space and vacuity. If the secondary qualities of bodies, or their powers, variously to affect our senses, depend on their primary qualities, it is chiefly on this of solidity; which is therefore the most important of the primary qualities, and that in which the essence of body is by some conceived to consist. This idea of solidity has been judged to be incapable of any analysis; but it appears evident to me (continues our author), that the idea of solidity may be resolved into another idea, which is that of the power of resisting within the extension of body. Hence it becomes unnecessary, and even inadmissible, to suppose that solidity in the body is at all a pattern or archetype of our sensation."

That solidity in the body, and we know nothing of solidity any where else, is no pattern of any sensation of ours, is indeed most true, as we have shown at large in another place, (see METAPHYSICS, n° 44 and 171): but to reconcile this with what our author asserts immediately afterwards, that "solidity is no more in bodies than colours and flavours are, and that it is equally with them a *sensation* and an *idea*," would be a task to which our ingenuity is by no means equal. He affirms, indeed, that solidity, as it is said to be in bodies, is utterly incomprehensible; that we can perfectly comprehend it as a sensation in ourselves, but that in bodies nothing more is required than a power of active resistance to make upon our senses those impressions from which we infer the reality of primary and secondary qualities. This power of resistance, whether it ought to be called active or passive, we apprehend to be that which all other philosophers have meant by the word *solidity*; and though Locke, who uses the words *idea* and *notion* indiscriminately, often talks of the *idea* of solidity, we believe our author to be the first of human beings who has thought of treating *solidity* as a sensation in the mind.

Though it is wrong to innovate in language, when writing on subjects which require much attention, we must, however, acknowledge it to be unworthy of inquirers after truth to dispute about the proper or improper use of terms, so long as the meaning of him who employs them can be easily discovered. We shall, therefore, follow our author in his endeavours to ascertain what this power of resistance is which is commonly known by the name of solidity. All power he justly holds to be active; and having, by an argument (A) of which we do

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"(A) We can only conceive of solidity as being a resistance of the *parts* of any body, to a power which endeavours

Plastic.

not perceive the force, attempted to prove that it is by an inward *power*, and not by its *inertia*, that one body prevents another from occupying the same place with itself, he naturally enough infers matter to be essentially active. "But the activity of matter is to be considered in a certain limited sense, and its inertness is to be regarded in another limited sense; so that these are compatible within their respective limits. The activity of body may be considered as belonging to the parts of a compound; its inertia as the inertia formed of those parts. The actions of the parts are everywhere opposed to each other, and equal; and hence results the inactivity of the whole."

SOLIDITY alone of the primary qualities being positive, and peculiar to bodies, and our author having resolved this into ACTION or POWER, it follows, by his analysis, that the ESSENCE OF BODY is reduced to power likewise. But, as he properly observes, power is an idea of reflection, not acquired by the senses, but suggested by thought. Hence our knowledge of real existence in body must be such as is suggested to us by our thoughts exercised about our sensations. "We are capable of acting and producing changes in appearances; and this faculty, which we experience to exist in ourselves, we call power. We are conscious of the exertion of our own power; and therefore, when we see ACTION or CHANGE happen without any exertion of ours, we refer this to other powers without us, and necessarily conclude the POWER to exist where the change begins or the action is exerted. This power, then, referred to bodies, must exist in them, or it can exist nowhere."

In two chapters, which might easily have been compressed into one not so long as the shortest of them, our author analyzes *atoms* or the primary particles of matter, and strenuously opposes their impenetrability. He allows that there are atoms of matter not divisible by any known force; but as these, however small, must still be conceived as having extension, each of them must be composed of parts held together by the same power which binds together many atoms in the same body. This power, indeed, he acknowledges to operate much more forcibly when it cements the parts of a primary atom than when it makes many atoms cohere in one mass; but still it operates in the same manner: and as the ideal analysis

may be carried on *ad infinitum*, the only positive idea which is suggested by atoms, or the parts of atoms, is the idea of a resisting power. That this power of resistance, which constitutes what is vulgarly called the solidity of bodies, may not be absolutely impenetrable, he attempts to prove, by showing that resistance does in fact take place in cases where impenetrability, and even solidity, are not supposed by any man.

"Let us endeavour (says he) to bring together two like poles of a magnet, and we shall experience a resistance to their approximation. Why, then, may not a piece of iron, which between our fingers resists their coming together, resist by an efficacy perfectly similar, though more strongly exerted? If magnetism were to act upon our bodies as upon iron, we should feel it; or were magnets endowed with sensation, they would feel that which resists their nearer approach. The resisting extension between the two magnets is permeable to all the rays of light, and reflecting none is therefore unseen; but it is easy to conceive that the same power which resists the approach of the iron might resist and reflect some rays of light. We should then have a visible object interposed between the two magnets, as we have before supposed it might be a tangible one. It is likewise easy to conceive that which is tangible and visible so applied to our organs of tasting, of smelling, and of hearing, as to excite ideas of flavours, odours, and sounds. Thus we see that an action, in which no supposition of solidity or impenetrability is involved, may be conceived to assume all the qualities of matter, by only supposing a familiar effect extended in its operation."

This reasoning is exceedingly ingenious, though perhaps not original; but what is of more importance, it does not approach so near to demonstration as the author seems to imagine. If magnets operate by means of a fluid issuing from them (see MAGNETISM, chap. 3.), those who hold the solidity or impenetrability of matter will maintain, that each atom of the magnetic fluid is solid and impenetrable. That we do not see nor feel these atoms, will be considered as no argument that they do not exist; for we do not see, nor in a close room feel, the atoms of the surrounding atmosphere; which yet Mr Young will acknowledge to have a real existence, and to be capable of operating upon our senses of hearing and smelling. Let us, however, suppose, that by this reasoning

vours to *separate* them, or to bring them *nearer* together. Now that which resists any power, and prevents its effect, is also a power. By resistance, I mean here an active resistance, such as an animal can employ against an animal. If a horse pulls against a load, he draws it along; but if he draws against another horse, he is put to a stand, and his endeavour is defeated. When any endeavour to change the situation of the parts of any solid is in like manner prevented from taking effect, and the parts retain their situation, the situation has plainly been preserved by an active resistance or power, equivalent to that which was fruitlessly exerted on them."

Such is our author's reasoning to prove that matter is essentially active, and that from this activity results our notion of its solidity: but does he not here confound solidity with hardness, and impenetrability with cohesion? He certainly does; for *water* is as *solid*, in the proper sense of the word, as *adamant*, and the particles of *air* as the particles of *iron*. The parts of water are, indeed, separated with ease, and those of adamant with difficulty; but it is not because the latter have more solidity than the former, but because the power of cohesion, whatever it may be, operates upon them with greater force. Solidity is an attribute of a whole; hardness and softness results from the cohesion of parts. We do not at all perceive the propriety of the simile of the horse pulling a load, and afterwards pulling against another horse. Is it because both horses are *active* that one of them cannot prevail against the other, and because the load is *inactive* that either of them may drag along a mass of iron of half a tun weight? If so, double or triple the mass, and a very strange phenomenon will be the result; for we shall have an active whole compounded of two or three inactive parts, even though those parts should not be in contact!

Plastic.

reasoning he has established the non-existence of every thing in the primary atoms of matter but active powers of resistance, and let us see how he conceives the actions of these powers to constitute what gives us the notion of inert and solid body; for that we have such a notion cannot be denied.

To ACT he allows to be an attribute, and justly observes, that we cannot conceive an attribute to exist without a substance. "But (says he) we have traced all phenomena to action as to a generic idea, comprehending under it all forms of matter and motion as species of that genus. By this analysis, that complex idea we have usually denominated matter, and considered as the substance or substratum to which motion appertained as an attribute, is found to change its character, and to be itself an attribute of a substance essentially active, of which one modification of motion produces matter and another generates motion." The action of this substance Mr Young determines to be motion (see MOTION, n° 16.); and he proceeds to inquire by what kind of motion it produces matter, or inert and resisting atoms.

"Whatever portion of the ACTIVE SUBSTANCE is given to form an atom, the following things are necessary to be united in such portion of active substance: 1st, It must in some respect continually move; for otherwise it would lose its nature, and cease to be active. 2^{dly}, It must also in some other respect be at rest, for otherwise it could not form an inactive atom. 3^{dly}, It must preserve unity within itself." The author's proof of the first of these positions we have given elsewhere. The second he holds to be self-evident; and the third he thinks established by the following reasoning: "Solidity is the result of those actions among the parts of any whole, whereby the unity of the whole is preserved within itself. Several uncohering things may be united by an external bond: this does not constitute these one solid; it may be one bundle: but if several things cohere, and have a unity preserved within themselves, they become one solid. An atom is the least and most simple solid."

Having thus proved the necessity of these three requisites to the formation of an atom, he observes, that "the two first can only be united in a rotation of the portion of active substance about a centre or axis at rest. By such a motion, *all the parts* successively occupy *different places* in the orbit of rotation, and therefore move; the centre round which they revolve being at rest, the *whole portion* is also at rest; and thus the portion is at once moving and quiescent, as is required. The same kind of motion will also fulfil the terms of the third requisite; for a substance having a revolving motion around its own centre, preserves its unity by reason of all the parts preserving the same relation to the centre: and further, a motion of the active substance about a centre or axis will be an activity in the same orbit, which will act upon and resist whatever shall interfere to oppose its activity, or destroy the unity of the sphere, by diverting the course of the revolving motions. The activity or motion of a portion of ACTIVE SUBSTANCE about a centre will, therefore, give solidity to such portion; for it will give it unity and resistance, and in a manner tie together all the parts, forming them into one mass about their common centre: for they move or are active not *towards* the centre, in which case they would be lost in non-exten-

Plastic.

sion; nor *from* the centre, where they would dissipate in boundless space; but *about* the centre, preserving the same limits of extension: and being in this way active, they in this way resist any other activity opposed to them, that is, they resist any action which tends to penetrate or divide this sphere of revolving activity. Therefore, since any portion of active substance does, by revolving about a centre, become an united, resisting, and quiescent whole, the smallest portions of the ACTIVE SUBSTANCE which have such motions will become *atoms*, or make the smallest portions of matter."

Having thus shown to his own satisfaction how atoms of matter are formed, he next explains what at first he confesses may have appeared a paradox, "how the ACTIVE SUBSTANCE, retaining its own nature and essential properties, continuing immaterial, unsolid, and active, puts on at the same time the form of matter, and becomes material, solid, and inert. A sphere of revolving active substance, as it revolves continually about a centre, and as parts of the substance, are considered as successively passing through every point in the orbit; considered thus in its parts, and in its motions, it is ACTIVE SUBSTANCE, immaterial, and unsolid; but the whole sphere, considered unitically, collectively, and as quiescent, is in this point of view a solid atom, material, and inert."

Such is the active substance of Mr Young, and such his theory of the formation of matter. That he has not with servility copied from the ancients, every reader of his book, who is not an absolute stranger to Greek and Roman literature, will readily acknowledge; and yet if his theory be well founded, he has discovered a middle substance between mind and matter, more properly *plastic* than Aristotle or Plato, Cudworth or Berkeley, ever conceived. But truth compels us to add, that to us his theory appears to labour under insuperable objections. That there *may* be in the universe a substance essentially active, and at the same time not intelligent, is a proposition which we are by no means inclined to controvert. Various phenomena, both in vegetable and animal life, lead us to suspect that there is such a substance; but it does not follow that we are inclined to adopt our author's doctrine respecting the formation of matter. He conceives his proof, indeed, to be "in its nature not at all imperfect, or to fall short of demonstration; and if any one refuse it, he thinks it will be necessary for him to show, either that the explanation offered is not sufficient, or that some other explanation will serve equally well."

To show that the explanation offered is not sufficient, will not, we apprehend, be a very arduous task; but we have no inclination to attempt ourselves another explanation, because we believe that of the formation of matter no other account can be given than that which resolves it into the *fiat* of the Creator. That it cannot be formed by the motion of an immaterial substance in the manner which our author has very clearly described, seems to be a truth so evident as not to admit of proof; for if motion be, as he defines it, a change of place, every thing that is moved must have the quality of extension. But all the parts of this active substance which are given to form an atom, move round a centre, and are expressly said to occupy successively different *places* in the orbit of rotation. Every one of these parts, therefore, is an extended being: and since, according to our

author,

Plastic.

author, solidity is nothing but an *active power of resistance*, and the parts of this active substance, in their rotation round their centre, *act upon* and *resist* whatever interferes to oppose their activity, it follows that each of these parts is likewise a *solid being*. But, in the opinion of Mr Young himself, and of all mankind, whatever is extended and solid is material. This theory, therefore, exhibits a process in which atoms are formed of a substance, which, though it is said to be *active, immaterial*, and unsolid, appears, when narrowly inspected, to be nothing else than a collection of those very atoms of which the author pretends to explain the formation. Mr Young, who examines and very freely censures some of the doctrines of Newton and others, is too much a man of science to be offended at us for stating objections to a theory which is quite new, to a transformation which he himself acknowledges may to many "appear not only problematical and difficult to conceive, but wholly impossible, and implying contradictions absolutely and for ever irreconcilable." Whether this be a just character of it our readers must determine; but if we did not believe the author to be a man of ingenuity, we should not have introduced him or his work to their acquaintance.

PLASTIC Art, the art of representing all sorts of figures by the means of moulds. This term is derived from the Greek word *πλαστική*, which signifies the "art of forming, modelling, or casting, in a mould." A mould in general is a body that is made hollow for that purpose. The artist makes use of them to form figures in bronze, lead, gold, silver, or any other metal or fusible substance. The mould is made of clay, stucco, or other composition, and is hollowed into the form of the figure that is to be produced; they then apply the jet, which is a sort of funnel, through which the metal is poured that is to form the figures, and that is called *running the metal into the mould*.

It is in this manner, but with much practice and attention, that the artist forms, 1. Equestrian and pedestrian statues of every kind; 2. Groups; 3. Pedestals; 4. Bases-reliefs; 5. Medallions; 6. Cannons, mortars, and other pieces of artillery; 7. Ornaments of architecture, as capitals, bases, &c.; 8. Various sorts of furniture, as lustres, branches, &c. in every kind of metal: and in the same manner figures are cast in stucco, plaster, or any other fusible matter. See *PLASTER of Paris*.

Wax being a substance that is very easily put in fusion, plastics make much use of it. There are impressions which are highly pleasing in coloured wax, of medallions, basso and alto relievos, and of detached figures; which, however, are somewhat brittle. But this matter has been carried too far: they have not only formed moulds to represent the likenesses and the bust of a living person, by applying the plaster to the face itself, and afterwards casting melted wax into the mould; but they have also painted that waxen bust with the natural colours of the face, and have then applied glass eyes and natural hair; to which they have joined a stuffed body and limbs, with hands of wax; and have, lastly, dressed their figure in a real habit; and by these means have produced an object the most shocking and detestable that it is possible to conceive. It is not a statue, a bust, a natural resemblance that they form; but a dead body, a lifeless countenance, a mere carcase. The stiff air, the inflexible muscles, the haggard eyes of glass, all contribute to

produce an object that is hideous and disgusting to every man of taste. Figures like these offend by affording too exact an imitation of nature. In no one of the polite arts ought imitation ever to approach so near the truth as to be taken for nature herself. Illusion must have its bounds; without which it becomes ridiculous.

There is another invention far more ingenious and pleasing, which is that wherein M. Lippart, antiquary and artist at Dresden, has so much excelled. He has found the means of resembling, by indefatigable labour, great expence, and infinite taste, that immense number of stones, engraved and in cameau, which are to be seen in the most celebrated cabinets. He has made choice of those that are the most beautiful; and, with a paste of his own invention, he takes from these stones an impression that is surprisingly accurate, and which afterwards become as marble: these impressions he calls *pasti*. He then gives them a proper colour, and incloses each with a gold rim; and, by ranging them in a judicious order, forms of them an admirable system. They are fixed on pasteboards, which form so many drawers, and are then inclosed in cases, which represent folio volumes, and have titles wrote on their backs; so that these fictitious books may conveniently occupy a place in a library. Nothing can be more ingenious than this invention; and, by means of it, persons of moderate fortune are enabled to make a complete collection of all antiquity has left that is excellent of this kind; and the copies are very little inferior to the originals.

There is also another method of taking the impressions of cameaus, medals, and coins, which is as follows: They wash or properly clean the piece whose impression is to be taken, and surround it with a border of wax. They then dissolve isinglass in water, and make a decoction of it, mixing with it some vermilion, to give it an agreeable red colour. They pour this paste, when hot, on the stone or medal, to the thickness of about the tenth part of an inch; they then leave it exposed to the sun, in a place free from dust. After a few days this paste becomes hard, and offers to the eye the most admirable and faithful representation of the medal that it is possible to conceive: they are then carefully placed in drawers; and thousands of these impressions, which comprehend many ages, may be included in a small compass.

The proficient in plastics have likewise invented the art of casting in a mould papier maché or dissolved paper, and forming it into figures in imitation of sculpture, of ornaments and decorations for ceilings, furniture, &c. and which they afterwards paint or gild. There are, however, some inconveniences attending this art; as, for example, the imperfections in the moulds, which render the contours of the figures inelegant, and give them a heavy air: these ornaments, moreover, are not so durable as those of bronze or wood, seeing that in a few years they are preyed on by the worm.

The figures that are given to porcelain, Delft ware, &c. belong also to plastics; for they are formed by moulds, as well as by the art of the sculptor and turner; and by all these arts united are made vases of every kind, figures, groups, and other designs, either for use or ornament.

From this general article the reader is referred to *FOUNDRY, CAST, GLAZING, PORCELAIN, PAPIER-MACHÉ, POTTERY, DELFT Ware*.

PLATA,

Plata.

PLATA, the name of a very great river of South America, running through the province of Paraguay; whence the whole country is sometimes called *Plata*; though this name is usually bestowed only upon a part of Paraguay. In the latter sense it comprehends all that country bounded on the east and south-east by the Atlantic Ocean; on the south, by Terra Magellanica; on the west, by Tucuman; and on the north, by the provinces of Paraguay Proper and Parana. The great river La Plata, from which the country has its name, was first discovered, in 1515, by Juan Diaz de Solis; but denominated *La Plata* by Sebastian Gabato, from the great quantity of the precious metals he procured from the adjacent inhabitants, imagining it was the produce of the country, though in fact they brought it from Peru.

The country lies between 32° and 37° of south latitude. The climate is pleasant and healthy. Their winter is in May, June, and July, when the nights are indeed very cold, but the days moderately warm; the frost is neither violent nor lasting, and the snows are very inconsiderable.

The country consists mostly of plains of a vast extent, and exceeding rich soil, producing all sorts of European and American fruits, wheat, maize, cotton, sugar, honey, &c. and abounding with such excellent pastures, that the beasts brought thither from Spain are multiplied to such a degree, that they are all in common, no man claiming any property in them, but every man takes what he hath occasion for. The number of black cattle, especially, is so prodigious, that many thousands of them are killed merely for their hides, every time the ships go for Spain, and their carcasses left to be devoured by wild beasts and birds of prey, which are also very numerous. Sometimes, when they cannot vend their hides, they will kill them for their tongues; and those who care not to be at the trouble to fetch them from the plains, may buy them for a trifle. There is a curious account in Lord Anson's voyage of the manner of hunting them on horseback; and of catching and killing them, by throwing a noose on their horns at full gallop, the horses being trained to the sport. Horses are no less numerous, and in common like the other cattle; so that a man may have as many as he pleases for the catching; and of those that are already broke, one may buy some of the best, and of the true Spanish breed, for a piece-of-eight per head. Wild-fowl also is in great plenty here; partridges in particular are more numerous, and as large and tame as our hens, so that one may kill them with a stick. Their wheat makes the finest and whitest of bread; and, in a word, they seem to want for nothing here, especially the natives, but salt and fuel. The former the Spaniards have brought to them from other parts; and the latter they supply themselves with, by planting vast numbers of almond, peach, and other trees, which require no other trouble than putting the kernels into the ground, and by the next year, we are told, they begin to bear fruit. The return for European commodities is so great here, that it almost exceeds belief; an ordinary two-penny knife fetching a crown, and a gun of the value of 10 or 12 shillings 20 or 30 crowns, and so of the rest.

The river Plata rises in Peru, and receives a great many others in its course; the chief of which is the Paraguay. The water of it is said to be very clear and

sweet, and to petrify wood; and contains such plenty and variety of fish, that the people catch great quantities of them without any other instrument than their hands. It runs mostly to the south and south-east; and is navigable the greater part of its course by the largest vessels, and full of delightful islands. All along its banks are seen the most beautiful birds of all kinds; but it sometimes overflows the adjacent country to a great extent, and is infested by serpents of a prodigious bigness. From its junction with the Paraguay to its mouth is above 200 leagues. We may form some judgement of its largeness by the width of its mouth, which is said to be about 70 leagues. Before it falls into the Paraguay it is called *Panama*. See **PANAMA**.

PLATÆÆ (anc. geog.), a very strong town of Boeotia, in its situation exposed to the north wind (*Theophrastus*); burnt to the ground by Xerxes (*Herodotus*, *Justinus*); mentioned much in the course of the Persian war: Famous for the defeat of Mardonius, the Persian general; and for the most signal victory of the Lacedemonians and other Greeks under Pausanias the Lacedemonian, and Aristides an Athenian general (*Nepos*, *Diodorus*, *Plutarch*); in memory of which the Greeks erected a temple to Jupiter Eleutherius, and instituted games which they called *Eleutheria*; and there they show the tomb of those who fell in that battle (*Strabo*). It stood at the foot of mount Cithæron, between that and Thebes to the north, on the road to Athens and Megara, and on the confines of Attica and Megaris. Now in ruins.

PLATALEA, the **SPoonBILL**, in ornithology, a genus belonging to the order of grallæ. The beak is plain, and dilates towards the point into an orbicular form; the feet have three toes, and are half palmated. There are three species distinguished by their colour; and of these species there are three varieties; two of what is called the *white species*, and one of the *roseate*.

1, The white species, which *Linnaeus* calls *platalea leucorodia*, is about the size of a heron, but somewhat shorter in the neck and legs. The bill is more than half a foot long, and, like that of the rest of the genus, is shaped like a spoon: the colour of the bill is very various, being in some birds black, in others brown, and sometimes spotted; from the base to two-thirds of its length several indentations cross it, the rising parts of which are of a dark colour: the tongue is short and heart-shaped: the irides are grey: the skin of the lore round the eyes and of the throat is bare and black: the plumage is entirely white, though there have been specimens where the quills were tipped with black: the legs are generally either black or of a greyish brown colour; between the toes there is a membrane connected to the outer one as far as the second, and to the inner as far as the first joint.

"This bird (says Mr Latham) is found in various parts of the old continent, and from the Ferro isles near Iceland to the Cape of Good Hope. It frequents the neighbourhood of the sea; and has been met with on the coasts of France; at Sevenlunys, near Leyden, once in great plenty, annually breeding in a wood there. The nest is placed on high trees near the sea-side. The female lays three or four white eggs, powdered with a few pale red spots, and of the size of those of an hen. They are very noisy during breeding-time, like our rooks; are seldom found high up the rivers, chiefly frequenting the

Plataea,
Platalea.Plate
CXXCVII

Platalea,
Platanus.

the mouths of them. Their food is fish, which they are said not unfrequently to take from other birds, in the manner of the bald eagle; also mussels and other shell-fish being found in greatest numbers where these are plenty; and they will also devour frogs and snakes, and even grass and weeds, which grow in the water, as well as the roots of reeds. They are migratory, retiring to the warmer parts as the winter approaches, and are rarely seen in England. Their flesh is said to have the flavour of a goose, and is eaten by some, and the young birds have been thought good food. By many authors they are called *pelicans*."

The two varieties of this species are equal in size to the roseate species. The bill of the first is reddish; the plumage mostly white; the feathers of the wings partly white and partly black, and the legs reddish. The plumage of the other is entirely white, not excepting even the quills. It has a crest of feathers whose webs are very loose, and separated from one another; the bill is of a rufous grey colour, having red edges, and the legs are of a dull pale red. They both inhabit the *Philippine islands*.

2. The roseate species, or *platalea ajaja*, is but a little less than the white. The bill is marked all round with a furrow parallel to the edge, and is of a greyish white colour, so transparent as to show the ramification of the blood-vessels belonging to it: the forehead is of a whitish colour between the bill, and eyes, and throat: the plumage is a fine rose-colour, deepest on the wings: the legs are grey; the claws blackish; and the toes have membranes as in the last species. The variety of this species is entirely of a beautiful red colour, having a collar of black at the lower part of the neck; the irides are red. Mr Latham imagines it is the roseate in full plumage. It is said to be of a blackish chestnut the first year; becomes rose-coloured the second, and of a deep scarlet the third. It lives on small fish.

3. The dwarf species, or *platalea pigmea*, is about the size of a sparrow. The bill is black, longer than the head, flat at the end, and nearly of a rhomboidal form; the angles and top of the upper mandible are white; the tongue is smooth; the body is brown above and white beneath; the quills have white shafts; the tail is rounded, short, and of a brownish white colour; the feet have four toes, are cloven, and the claws are pointed. It inhabits Surinam and Guiana.

PLATANUS, the PLANE-TREE; a genus of the polyandria order, belonging to the monœcia class of plants.

Species. 1. The *orientalis*, oriental or eastern plane-tree, rises with a very straight smooth branching stem to a great height. It has palmated leaves, six or eight inches long and as much broad, divided into five large segments, having the side ones cut into two smaller, green above, and pale underneath; and long pendulous pedunculi, each sustaining several round heads of close-fitting very small flowers; succeeded by numerous downy seeds, collected into round, rough, hard balls. It is a native of Asia and many parts of the east, and grows in great plenty in the Levant. 2. The *occidentalis*, occidental, or western plane-tree, rises with a straight smooth stem, to a great height, branching widely round: it has lobated leaves, seven or eight inches long, and from nine or ten to twelve or fourteen broad, divided into three large lobes; and very small flowers, collected into round

heads, succeeded by round rough balls of seed. It is a native of Virginia and other parts of North America; where it attains an enormous size, and is remarkable for having its stem all of an equal girth for a considerable length: we have an account of some trees being eight or nine yards in circumference, and which, when felled, afforded 20 loads of wood. The varieties of these two species are the Spanish or middle plane-tree, having remarkably large leaves of three or five narrower segments; and the maple-leaved plane-tree, having smaller leaves, somewhat lobated into five segments, resembling the mapple-tree leaf.

All these elegant trees are of hardy temperature, so as to prosper here in any common soil and exposure in our open plantations, &c. and are some of the most desirable trees of the deciduous tribe. They were in singular esteem among the ancients of the east, for their extraordinary beauty, and the delightful shade they afforded by their noble foliage. The leaves commonly expand in May, and fall off early in autumn; and the flowers appear in spring, a little before the leaves, being succeeded by seeds, which in fine seasons frequently ripen here in September. These fine trees are singularly fitted for all ornamental plantations. Their straight growth, regular branching heads, and the lofty stature they attain, together with the extraordinary breadth of their luxuriant leaves, render them extremely desirable furniture to adorn avenues, lawns, parks, and woods; some disposed in ranges, some as single standards, others in clumps, some in groves, &c. They are most excellent for shade; for it is observable, that no tree is better calculated to defend us from the heat in summer, by its noble spreading foliage, and to admit the sun's rays more freely in winter, on account of the distance of its branches, which is always in proportion to the size of the leaves. They may also be employed in the collection of forest-trees, in woods, to grow up to timber, in which case they will also prove advantageous in time. In short, these noble trees claim the esteem of every one concerned in plantations of every kind; but more particularly in extensive ones, where they may be so variously disposed as to have a charming effect.

The *propagation* of these trees is by seed, layers, and cuttings. The seeds frequently ripen in these parts, and are also procured from other countries, and may be obtained of the nurserymen or seedsmen. The best season for sowing them is autumn, if they can be then possibly procured. Choose a somewhat shady moist soil; and having dug the ground, and raked it fine, form it into four-foot wide beds, and either scatter the seeds evenly on the surface and rake them in, or previously with the back of a rake turn the earth off the surface near half an inch deep into the alleys; then sow the seed, and directly, with the rake turned the proper way, draw the earth evenly over the seeds, and trim the surface smooth: many of the plants will rise in spring, and probably may not till the spring following. When they are one or two years old, plant them out in nursery rows, two or three feet asunder, and about half that distance in the lines; here to remain till of a proper size for final transplantation. The method of propagation by layers is very commonly practised in the nurseries, in default of seed, and by which they most readily grow; for which purpose, some stout plants for stools must be planted, which in a year after must be headed down

Vegetable Cabinet.

II	XVII
III	XVIII
IV	XIX
V	XX
VI	XXI
VII	XXII
VIII	XXIII
IX	
X	
XI	
XII	
XIII	XXIV
XIV	
XV	
XVI	

1 2 3 4 5 6 7 8 9 10 11 12 Inches.

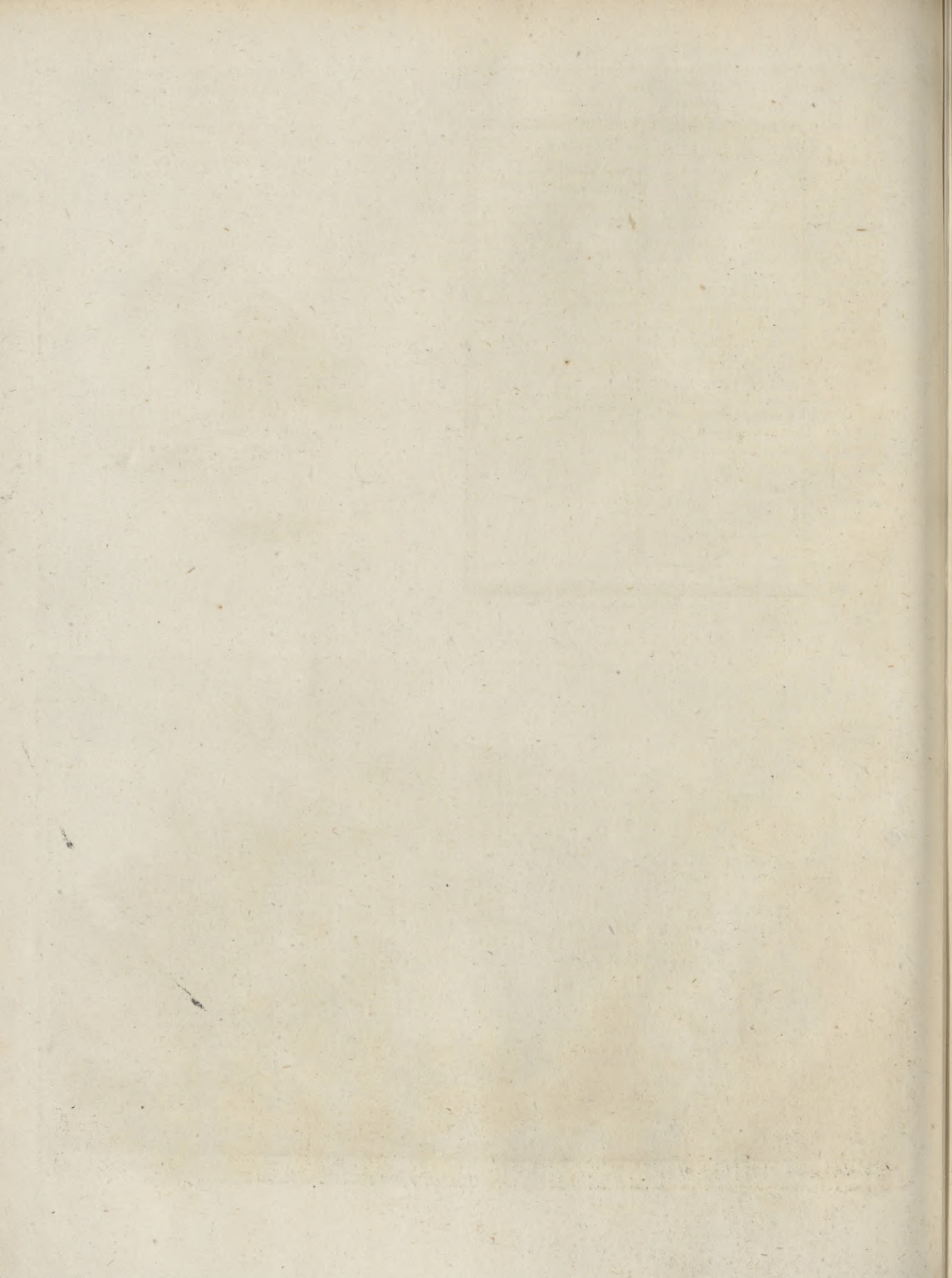
PLATALEA
or Spoon Bill.



The Mines of Pipsasfatto in the Island of Buaf.



W. Bell Pinx. W. A. Sculp. fecit.



Platband, near the bottom, that they may throw out many shoots near the ground, convenient for laying; which, in the autumn after they are produced, lay by for slit-laying; and by autumn after, they will be well rooted, and form plants two or three feet high, so may be separated, and planted in nursery-rows like the seedlings. All the sorts will take tolerably by cutting off the strong young shoots; but the *platanus occidentalis* more freely than the oriental kind. Autumn is the best season: as soon as the leaf falls, choose strong young shoots, and plant them in a moist soil; many of them will grow, and make tolerable plants by next autumn. It should be remarked, that, in order to continue the distinction of the varieties more effectually, they should be propagated either by layers or cuttings: for when raised from seed, those of the respective species generally vary.

PLATBAND, in gardening, a border or bed of flowers, along a wall, or the side of a parterre, frequently edged with box, &c.

PLATBAND of a door or window, is used for the lintel, where that is made square, or not much marked.

PLATE, a term which denotes a piece of wrought silver, such as the shallow vessel off which meat is eaten. It is likewise used by our sportsmen to express the reward given to the best horse at our races.

Stefman's Dictionary. The winning a plate is not the work of a few days to the owner of the horse; but great care and preparation is to be made for it, if there is any great dependence on the success. A month is the least time that can be allowed to draw the horse's body clear, and to refine his wind to that degree of perfection that is attainable by art.

It is first necessary to take an exact view of his body, whether he be low or high in flesh; and it is also necessary to consider whether he be dull and heavy, or brisk and lively when abroad. If he appear dull and heavy, and there is reason to suppose it is owing to too hard riding, or, as the jockeys express it, to some grease that has been dissolved in hunting, and has not been removed by scouring, then the proper remedy is half an ounce of diapente given in a pint of good sack; this will at once remove the cause, and revive the creature's spirits. After this, for the first week of the month, he is to be fed with oats, bread, and split beans; giving him sometimes the one and sometimes the other as he likes best; and always leaving some in the locker, that he may feed at leisure when he is left alone. When the groom returns at the feeding-time, whatever is left of this must be removed, and fresh given; by this means the creature will soon become high-spirited, wanton, and full of play. Every day he must be rode out an airing, and every other day it will be proper to give him a little more exercise; but not so much as to make him sweat too much. The beans and oats in this case are to be put into a bag, and beaten till the hulls are all off, and then winnowed clean; and the bread, instead of being chip-ped in the common way, is to have the crust clean cut off. If the horse be in good flesh and spirits when taken up for its month's preparation, the diapente must be omitted; and the chief business will be to give him good food, and so much exercise as will keep him in wind, without over-sweating him or tiring his spirits. When he takes larger exercises afterwards, towards the end of the month, it will be proper to have some horses in the place to run against him. This will put him upon his mettle, and the beating them will give him

spirits. This, however, is to be cautiously observed, that he has not a bloody heat given him for ten days or a fortnight before the plate is to be run for; and that the last heat that is given him the day before the race, must be in his clothes; this will make him run with greatly more vigour, when stripped for the race, and feeling the cold wind on every part.

In the second week, the horse should have the same food, and more exercise. In the last fortnight, he must have dried oats, that have been hulled by beating. After this they are to be wetted in a quantity of whites of eggs beaten up, and then laid out in the sun to dry; and when as dry as before, the horse is to have them. This sort of food is very light of digestion, and very good for the creature's wind. The beans in this time should be given more sparingly, and the bread should be made of three parts wheat and one part beans. If he should become colic under this course, he must then have some ale and whites of eggs beaten together; this will cool him, and keep his body moist.

In the last week the mash is to be omitted, and barley-water given him in its place, every day, till the day before the race: he should have his fill of hay; then he must have it given him more sparingly, that he may have time to digest it; and in the morning of the race day he must have a toast or two of white bread soaked in sack, and the same just before he is let out to the field. This is an excellent method, because the two extremes of fullness and fasting are at this time to be equally avoided; the one hurting his wind, and the other occasioning faintness that may make him lose. After he has had his food, the litter is to be shook up, and the stable kept quiet, that he may be disturbed by nothing till he is taken out to run.

PLATFORM, in the military art, an elevation of earth, on which cannon is placed to fire on the enemy; such are the mounts in the middle of curtains. On the ramparts there is always a platform, where the cannon are mounted. It is made by the heaping up of earth on the rampart, or by an arrangement of madders, rising insensibly, for the cannon to roll on, either in a casemate or on attack in the outworks. All practitioners are agreed, that no shot can be depended on, unless the piece can be placed on a solid platform; for if the platform shakes with the first impulse of the powder, the piece must likewise shake, which will alter its direction, and render the shot uncertain.

PLATFORM, in architecture, is a row of beams which support the timber-work of a roof, and lie on the top of a wall where the entablature ought to be raised.

This term is also used for a kind of terrace or broad smooth open walk at the top of a building, from whence a fair prospect may be taken of the adjacent country. Hence an edifice is said to be covered with a platform, when it is flat at top, and has no ridge. Most of the oriental buildings are thus covered, as were all those of the ancients.

PLATFORM, or *Orlop*, in a man of war, a place on the lower deck, abaft the main-mast, between it and the cockpit, and round about the main capstan, where provision is made for the wounded men in time of action.

PLATINA is a metallic substance lately discovered. The name, which has an allusion to its colour, is a diminutive of *plata*, and signifies "little silver." From its great specific gravity, and other resemblances which

Platina

it has to gold, it has been called *or blanc*, or *white gold*; from its refractory nature, *diabolus metallorum*; from some doubts entertained of its character as a metal, *juan blanco*, *white jack*, *white rogue*, or *white mock metal*. It has also received the appellation of the *eighth metal*; and, probably from some district which affords it, has gotten the name of *platina del Pinto*.

The first in Europe who mentioned it by its present name was Don Antonio Ulloa, a Spanish mathematician, who in 1735 accompanied the French academicians that were sent by their sovereign to determine the figure of the earth by measuring a degree of the meridian in Peru. In the relation of his voyage, which was published at Madrid in 1748, he says, that the golden mines in the territory of Choco had been abandoned on account of platina; which he represents as a hard stone not easily broken by a blow on the anvil, which could not be subdued by calcination, and from which the gold could not be extracted without much labour, much expence, and great difficulty.

The particular places of Choco where it is found are Novita and Citara; but in what quantity it is there to be met with is not ascertained. The miners, discovering at an early period that it was a metal, had begun to employ it in adulterating their gold; and the court of Spain, it is said, dreading the consequences, took measures not only to prevent its exportation, but partly to conceal the knowledge of it from the world. It is reported in the Chemical Annals for July 1792, that when the gold is brought from Choco to be coined in the two mints of Santa-fe, in that of Bogota and Popayan, the gold undergoes a new examination, the platina that remains is carefully separated, and being given to officers appointed by the king, they, as soon as a certain quantity is collected, carry it away, and before witnesses throw it into the river Bogota, at two leagues distance from Santa-fe, or into the Cauca, about one league distant from Popayan.

In the Physical Journals for November 1785 we are told, that the primitive mines which produced it have not yet been discovered in any part of the globe, and that those which furnish it at present are of the secondary kind, being strata of loose earth washed down from the higher grounds. In these strata the particles are reported to be from the size of a millet seed to that of a pea. The author of the account says, that he had some pieces which weighed from 15 to 20 grains; and adds, that on trying some of them between steel rollers in the presence of Messrs Darcet and Tillet at Paris, they were perfectly laminated. He says also, that a native piece of platina was found nearly of a square figure, and almost as large as a pigeon's egg, which was deposited in the Royal Society of Biscay. M. de Buffon, however, says expressly, that "a person of credit had assured him that platina is sometimes found in large masses; and that he had seen a lump of it weighing no less than 20 lib. which had not been melted, but taken in that state out of the mine." As to the small particles, they are of a whiter colour than iron, with a smooth surface. Their figure is generally of an oblong form, very flat, rounded in the edge, and has been ascribed to the hammering of the mills in which the gold is amalgamated.

The heterogeneous substances with which the platina is generally mixed are particles of gold, grains of quartz

Platina

or crystal, some sand of a brownish hue, and some dust of a dark colour obedient to the magnet, and which seems to be fragments of other irregular dark-coloured particles, which resemble pieces of emery or loadstone. Dr Ingenhoufz, however, says, that every particle even of some fine platina which he examined obeyed the magnet more or less, excepting some that were transparent and stony; and that these were all magnets in themselves, or that each of these particles had two poles, which he could change at pleasure by magnetic bars. In about 72 pounds weight of platina which was brought from Spanish America, M. Magellan found not only a large quantity of ferruginous sand, but many pieces of vegetable stalks, a number of seeds, and some very small red crystals like rubies. These crystals being sent to M. Achard of Berlin, he tried them as far as their minuteness and small quantity would permit, and at last concluded that they really were rubies. As for the mercurial globules which are sometimes intermixed with the particles of platina, they are entirely foreign to its mines. They are now generally thought to be part of the mercury that has been employed in amalgamation; and which could not be brought from a place less distant than Guancavelica, about 900 miles from the province of Choco where the platina is found.

This metal, though not under its present name, which was first mentioned by Don Ulloa, has perhaps been known in Europe since 1741. At that period Charles Wood found in Jamaica some platina which was brought from Carthagena. He even made some chemical trials of it. Among others, he attempted to cupel it; and observes, in the account which he gave of it in 1749, that the Spaniards had a method of casting it into different sorts of toys, which are common enough in the Spanish West Indies. It was probably, too, imported into Spain soon after its discovery in America. It is said that Rudenschoel carried some of it from Spain to Stockholm in 1745; and the first important set of experiments that appeared on the subject were those of Scheffer, one of the members of the Swedish Academy. They were published in 1752; and gave this information, that platina is easily fusible with arsenic, but when alone remains unchanged by the most violent heat of the furnace. Two years after Dr Lewis published some papers concerning this metal in the Royal Philosophical Transactions of London. This eminent chemist, in the course of his experiments, had examined it both in the dry and the wet way; discovered a number of its relative affinities; mixed it in different proportions with different metals; and had fused it with arsenic, though he did not afterwards attempt to separate them.

In 1757 Margraaf published several very interesting observations about the method of separating it from the iron which always accompanies it.

In 1758 and 1763 Macquer and Beaumé made upon it a considerable number of experiments together, and formed of it at last a concave mirror. See *Chém. miftr.* n° 1321.

And it was in 1780 that the *Journaux de Physique* gave an account of the labours of Bergman on the same subject.

The platina of which the toys were made in the Spanish West Indies was found by Dr Lewis to be always mixed with some other metals. What these particular mixtures were is not well known; but many of the alloys formed by Dr Lewis himself have promised to be both

Platina. both ornamental and useful. He found that platina, which is $\frac{1}{7}$ of the whole mass, will render gold no paler than a guinea, which contains only $\frac{1}{12}$ of silver. He found that copper was much improved by alloying it with platina in certain proportions; and that equal parts of platina and brass formed a compound not subject to tarnish, and which might be employed with great advantage for the speculums of telescopes.

Besides alloying it with the different metals, it was an object equally interesting to the chemists and society that platina should be obtained pure and unmixed; and that means should be contrived to render it fusible, malleable, and ductile. We are now to see what the chemists have done to accomplish these ends. They readily saw that it would be necessary, in the first place, to bring it to a state of ultimate division, and that this should be tried in one or other of these two ways; by dissolving it in acids, or by fusing it along with some other metal; for by itself it had hitherto proved absolutely unfusible, except when exposed to the focus of a large burning glass, or the kindled stream of dephlogisticated or vital air. Among the methods which they employed to separate it from gold, the principal were the following: The first was by uniting the mixture of platina and gold with mercury, and grinding the amalgam for a considerable time with water; in which process the platina was gradually thrown out, and the gold retained by the quicksilver. Another method was by mixing a few drops of a solution of platina with above a hundred times the quantity of a solution of gold, and gradually adding a pure fixed alkaline salt as long as it occasioned any effervescence or precipitation. The remaining liquor in this case was so yellow, that it has been judged the platina would discover itself, though its proportion had been less than a thousandth part of that of gold. A third mode of separating platina and gold was that of precipitation, by means of mineral fixed alkali; for when this alkali is mixed with a solution of gold containing platina, the gold alone is precipitated, and all the platina remains dissolved. Another method was by precipitation of the platina with sal ammoniac. For this purpose, to a solution of the metal in aqua regia a small quantity of the solution of sal ammoniac in water was added; and if the gold contained any platina, the liquor instantly grew turbid, and a fine yellow or reddish precipitate quickly fell to the bottom; if the gold was pure, no precipitation or change of transparency ensued. The fifth method of separation was by means of inflammable liquors. The compound to be examined was dissolved in aqua regia: the solution mingled with twice its quantity or more of rectified spirit of wine, and the mixture suffered to stand for some days in a glass slightly covered, the gold rose to the surface, leaving the platina dissolved. Otherwise, to the solution of the metal in aqua regia about half its quantity of any colourless essential oil was added: the two were shaken well together, and suffered to rest; upon which the oil rose immediately to the surface, carrying the gold with it, and leaving the platina dissolved in the acid under it. Or, the gold was taken up still more readily and more perfectly by ether, or the ethereal spirit of wine. But, after all, the most effectual and advantageous method of separating platina from gold was founded on a property which gold has, and not platina, of being capable of precipitation from aqua

Platina. regia by martial vitriol; and upon a property which platina has, and not gold, of being capable of precipitation from aqua regia by sal ammoniac. When therefore we would discover if gold be alloyed with platina, let it be dissolved in aqua regia; and to this solution, which will contain both metals, let some sal ammoniac dissolved in water be added; upon which the platina will be precipitated in form of a brick-coloured sediment. If, on the other side, we would know if platina contain any gold, let this platina be dissolved in aqua regia, and to the solution add a solution of martial vitriol in water; upon which the liquor will become turbid, and the gold will form a precipitate which may be easily separated by decanting and filtrating the liquor. This property which platina possesses of being precipitated by martial vitriol was first discovered by M. Scheffer.

With respect to the iron contained among the platina, M. de Buffon separated, by means of a magnet, six parts out of seven of a parcel of platina. He distinguished two different matters in platina; of which one was black, friable, and attractable by magnets; and the other consisted of larger grains, was of a livid white or yellowish colour, much less attractable, and was extensible. Between these two different matters were many intermediate particles, some partaking more of the former, and some of the latter. He thought that the black matter was chiefly iron; and says, that he had observed a similar black powder in many ores of iron.

M. Morveau found, that a Prussian blue could be obtained from the black part of the platina, by pouring upon it spirit of nitre, and afterwards adding to the solution diluted some phlogisticated alkali; and that the particles of platina which could not be attracted by magnets, did not by this method show any sign of their containing iron.

But the most important discovery concerning the separation of platina from other metals was a method of melting it, by which it became a perfect metal, malleable, and denser than gold. It was in 1773 and 1774 that M. de Lisle effected this, by dissolving crude platina in aqua regia, precipitating it from the acid menstruum by sal ammoniac, and by fusing this precipitate, without addition, in a double crucible, exposed to the intense heat of a forge-fire excited by double bellows. M. Morveau has repeated the experiment, and found that he could melt the precipitate with several fluxes; he found likewise that by means of white glass, borax, and charcoal, he could melt even crude platina, and could alloy together platina and steel in various proportions.

M. de Sickengen was the inventor of another method: he dissolved his platina in aqua regia, and precipitated the iron by the prussiate of potash. In evaporating this liquor he obtained small octaedral crystals of the colour of rubies; which, being exposed to a strong heat, yielded a metal which bore easily the stroke of the hammer, which could be readily drawn into wire, and was extremely malleable.

In attempting to refine platina by the dry way, cupellation was a method to which the chemists early had recourse; but, notwithstanding their utmost endeavours, it has not been attended with all the success which could have been wished. It was found that the scorification proceeded as well at the beginning of the operation, as when gold and silver are cupelled: but the cupellation

Plati. a. afterwards became more and more difficult; because, as the quantity of lead diminished, the matter became less and less fusible, and at last ceased to be fluid, notwithstanding the most violent heat; and also because, when the quantity of platina was greater than that of the lead, this latter metal was protected, and not converted into litharge. Hence the regulus obtained was always dark-coloured, rough, adhering to the cupel, brittle, and weighing more than the platina originally employed, from the lead which remained united with it. Mess. Macquer and Beaumé appear nevertheless to have carried this experiment further: they kept the matter exposed to a violent fire during a longer time; that is, about 50 hours successively: and therefore, although their platina was tarnished and rough on its surface, it was internally white and shining, easily separable from the cupel, and a little diminished in weight; a certain proof that no lead remained in it. This platina was also ductile, and capable of extension under the hammer.

Cupellation, therefore, though not the best, is at least a certain method of applying platina to use, and of forming it into utensils.

What has been thought a preferable method, is first to fuse the platina with arsenic, and afterwards dissipate this last metal by a strong heat: by this means Achiard and Rochon were able to obtain a pure platina; of which the former made some small crucibles, and the latter, by alloying it with copper and tin, some large mirrors for reflecting telescopes.

Jeanety of Paris has gone still farther: besides snuff-boxes, watch-chains, and a coffee-pot of platina prepared by this artist, the world has seen a lens weighing six pounds, a ball weighing nine, and two bars 19 feet long, and weighing no less than 11 pounds each. This gentleman has the merit of being the first who wrought this metal in the great way. The method he employed was far from being new; it had been suggested by Scheffer, by Willis, by Margraaf, and was afterwards practised by Achiard, Morveau, and a great many others, but who always prepared it in very small quantities. In the Chemical Annals for July 1792, the following account of it is given by himself.

The platina is first pounded in water to disengage it from the ferruginous and other heterogeneous particles that are mixed with it. "This being done, I take (says he) one pound and a half of platina, two pounds of white arsenic in powder, and one pound of purified potash. I mix the whole: I put a crucible in the fire capable of containing about 20 pounds; when my furnace and crucible are well heated, I throw into the crucible one third of the mixture, and apply a good heat; I then add a second quantity and a third, and so on, always taking care at every time to mix the whole with a rod of platina. I give now a considerable force to the fire; and when I am certain that the whole is completely in a state of fusion, I withdraw my crucible and leave it to cool. After breaking it, I find a button that is well formed and attractable by the magnet. I bruise this button into small pieces, and fuse it a second time in the same manner: if this second fusion, which it generally is, be not sufficient to effect the separation of the iron from the platina, I fuse it a third time; but if I be obliged to do it a third time, I always put two buttons together, to save at once a crucible and charcoal.

This first operation being finished, I take a crucible

with a flat bottom and of a circumference to give to the button about three inches and a quarter in diameter. I make this crucible red hot, and throw into it one pound and a half of the platina which has been already fused with the arsenic after it was broken into small pieces; to this I add a quantity of arsenic of the same weight, and about half a pound of refined potash. I give to the fire a considerable force; and when I am certain that the whole is completely in a state of fusion, I withdraw my crucible and leave it to cool, taking care always to place it horizontally, that the button may be of an equal thickness. After breaking the crucible, I find a button clear and sonorous, and weighing commonly about 1 pound and 11 ounces. I have remarked, that in proportion to the quantity of arsenic combined with the platina, the purification always succeeds with the more or less promptness and ease; and the greater the proportion so much the better. In this state I put my button into a furnace under a muffle, which ought not to be higher than the edge of the button lying on its flat side, and inclining a little to the walls of the muffle. In this manner I place three buttons on each side of the muffle, and apply fire to my furnace, that the muffle may be equally heated throughout: as soon as the buttons begin to evaporate I shut the doors of my furnace, that the heat may be kept up to the same degree; this ought always to be carefully attended to even to the end of the operation, for even a temporary excess of heat might spoil the whole of my past operations and render them abortive. I cause my buttons to volatilize during six hours, always taking care to change their situation, that every part may receive an equal portion of heat: I then put them in common oil, and for a like time keep them in a fire sufficient to dissipate the oil in smoke. I continue this operation as long as the button emits vapours; and when the evaporation has ceased I push the fire as far as it will go by means of the oil. These arsenical vapours have a bright shining metallic appearance, which I never can obtain any other way, and without which I have never been able to render platina perfectly malleable.

"If these steps which are here pointed out be properly followed, the operation lasts only eight days. My buttons are then thrown into the nitrous acid, and afterwards boiled in distilled water, till no part of the acid remains with them: I now heap them together one above another, apply the strongest possible heat, and beat them with a hammer, taking always care at the first heat to make them red hot in the crucible, that no foreign bodies may mix with them, as before this compression they are only so many spongy masses. I afterwards heat them in a naked state (*les chauffe à nud*); and bringing them to a square form, I hammer them on all sides for a shorter or longer time according to their bulk."

Such is the process observed by Jeanety in fusing platina; but he thinks that the working of this metal is susceptible of still greater improvement. In 1788 it was accordingly proposed by some of the French chemists to fuse platina by mixing it with charcoal and phosphoric glass, and afterwards to expose the phosphure of platina to a heat sufficient to volatilize and dissipate the phosphorus. This method succeeded remarkably well with M. Relletier; but, besides being tedious, it is difficult to separate the last portions of the phosphorus; and as these operations are always costly, there are few artists

atina,
ating.

artists who are willing to undertake them. M. de Morveau has also fused platina with his vitreous flux, made of pounded glass, borax, and charcoal: and Beaumé has advised to fuse it with a slight addition of lead, bismuth, antimony, or arsenic, and by keeping the alloy in the fire a long time to dissipate the metals which have facilitated the fusion. Platina may likewise be fused with a metal soluble in an acid: the mixture being pulverized, the alloyed metal may be dissolved, and the powder of platina may then be fused with the flux of De Morveau; or, instead of using a soluble metal, a calcinable metal may be employed, and heated as before †.

Chaptal.

The colour of platina, when properly refined, is something between that of iron and silver; it has no smell, and is the heaviest body yet known in nature. According to Mr Kirwan its specific gravity is to that of water as 23 to 1. It may likewise be said to be the most durable of all the metals: it is harder than iron; it undergoes no alteration in the air, and fire alone does not even appear to possess the power of changing it; for which reason it forms the best of all crucibles that have yet been invented. It resists the action of acids, alkalis, and sulphurs: it may be rolled into plates as fine as leaves of gold which are used in gilding; it is likewise extremely ductile: and Dr Withering tells us, that a wire of platina is stronger than a wire of gold or of silver of the same thickness; it is preferable to gold by the property which it has of folding or welding without mixture; and it unites, says Chaptal, two qualities never before found in one and the same substance. When formed into a mirror, it reflects but one image, at the same time that it is as unchangeable as a mirror of glass.

As those motives which at first prepossessed the court of Spain against this metal no longer exist, it is to be hoped that the decree which was passed against it will soon be revoked, and that the Spanish monarch will neither despise so rich a treasure as his mines of platina, nor refuse to the world the numerous advantages that may be derived from a substance that promises to be of so much importance in commerce and the arts.

PLATING is the art of covering baser metals with a thin plate of silver either for use or for ornament. It is said to have been invented by a spur-maker, not for show but for real utility. Till then the more elegant spurs in common use were made of solid silver, and from the flexibility of that metal they were liable to be bent into inconvenient forms by the slightest accident. To remedy this defect, a workman at Birmingham contrived to make the branches of a pair of spurs hollow, and to fill that hollow with a slender rod of steel or iron. Finding this a great improvement, and being desirous to add cheapness to utility, he continued to make the hollow larger, and of course the iron thicker and thicker, till at last he discovered the means of coating an iron spur with silver in such a manner as to make it equally elegant with those which were made wholly of that metal. The invention was quickly applied to other purposes; and to numberless utensils which were formerly made of brass or iron are now given the strength of these metals, and the elegance of silver, for a small additional expence.

The silver plate is generally made to adhere to the baser metal by means of solder; which is of two kinds, the *soft* and the *hard*, or the *tin* and *silver* solders. The

former of these consists of tin alone, the latter generally of three parts of silver and one of brass. When a buckle, for instance, is to be plated by means of the soft solder, the ring, before it is bent, is first tinned, and then the silver-plate is gently hammered upon it, the hammer employed being always covered with a piece of cloth. The silver now forms, as it were, a mould to the ring, and whatever of it is not intended to be used is cut off. This mould is fastened to the ring of the buckle by two or three cramps of small iron-wire; after which the buckle, with the plated side undermost, is laid upon a plate of iron sufficiently hot to melt the tin, but not the silver. The buckle is then covered with powdered resin or anointed with turpentine; and lest there should be a deficiency of tin, a small portion of rolled tin is likewise melted on it. The buckle is now taken off with a tongs, and commonly laid on a bed of sand, where the plate and the ring, while the solder is yet in a state of fusion, are more closely compressed by a smart stroke with a block of wood. The buckle is afterwards bent and finished.

Sometimes the melted tin is poured into the silver-mould, which has been previously rubbed over with some flux. The buckle ring is then put among the melted tin, and the plating finished. This is called by the workmen *filling up*.

When the hard solder is employed, the process is in many respects different. Before the plate is fitted to the iron or other metal, it is rubbed over with a solution of borax. Stripes of silver are placed along the joinings of the plate; and instead of two or three cramps, as in the former case, the whole is wrapped round with small wire; the solder and joinings are again rubbed with the borax, and the whole put into a charcoal fire till the solder be in fusion. When taken out the wire is instantly removed, the plate is cleaned by the application of some acid, and afterwards made smooth by the strokes of a hammer.

Metal plating is when a bar of silver and copper are taken of at least one equal side. The equal sides are made smooth, and the two bars fastened together by wire wrapped round them. These bars are then sweated in a charcoal fire; and after sweating, they adhere as closely together as if they were soldered. After this they are flattened into a plate between two rollers, when the copper appears on one side and the silver on the other. This sort of plate is named *plated metal*.

French plating is when silver-leaf is burnished on a piece of metal in a certain degree of heat.

When silver is dissolved in aquafortis, and precipitated upon another metal, the process is called *silvering*. See SOLDERING.

PLATO, an illustrious philosopher of antiquity, was by descent an Athenian, though the place of his birth was the Island of Egina. His lineage through his father is traced back to Codrus the last king of Athens; and through his mother to Solon the celebrated legislator. The time of his birth is commonly placed in the beginning of the 88th Olympiad; but Dr Knifield thinks it may be more accurately fixed in the third year of the 87th Olympiad, or 430 years before the Christian era. He gave early indications of an extensive and original genius, and had an education suitable to his high rank, being instructed in the rudiments of letters by the grammarian Dionysius, and trained in athletic exercises by

Aristo.

Plating,
Plato.

Plato.

Aristo of Argos. He applied with great diligence to the study of the arts of painting and poetry; and made such proficiency in the latter, as to produce an epic poem, which, upon comparing it with the poems of Homer, he committed to the flames. At the age of 20 he composed a dramatic piece; but after he had given it to the performers, happening to attend upon a discourse of Socrates, he was so captivated by his eloquence, that he reclaimed his tragedy without suffering it to be acted, renounced the muses, burnt all his poems, and applied himself wholly to the study of wisdom.

It is thought that Plato's first masters in philosophy were Cratylus and Hermogenes, who taught the systems of Heraclitus and Parmenides; but when he was 20 years old, he attached himself wholly to Socrates, with whom he remained eight years in the relation of a scholar. During this period, he frequently displeased his companions, and sometimes even his master, by grafting upon the Socratic system opinions which were taken from some other stock. It was the practice of the scholars of Socrates to commit to writing the substance of their master's discourses. Plato wrote them in the form of dialogues; but with so great additions of his own, that Socrates, hearing him recite his *Lysis*, cried out, "O Hercules! how many things does this young man feign of me!"

Plato, however, retained the warmest attachment to his master. When that great and good man was summoned before the senate, his illustrious scholar undertook to plead his cause, and begun a speech in his defence; but the partiality and violence of the judges would not permit him to proceed. After the condemnation, he presented his master with money sufficient to redeem his life; which, however, Socrates refused to accept. During his imprisonment, Plato attended him, and was present at a conversation which he held with his friends concerning the immortality of the soul; the substance of which he afterwards committed to writing in the beautiful dialogue intitled *Phædo*, not, however, without interweaving his own opinions and language.

The philosophers who were at Athens were so alarmed at the death of Socrates, that most of them fled from the city to avoid the injustice and cruelty of the government. Plato, whose grief upon this occasion is said by Plutarch to have been excessive, retired to Megara; where he was friendly entertained by Euclid, who had been one of Socrates's first scholars, till the storm was over. Afterwards he determined to travel in pursuit of knowledge; and from Megara he went to Italy, where he conferred with Eurytus, Philolaus, and Archytas. These were the most celebrated of the followers of Pythagoras, whose doctrine was then become famous in Greece; and from these the Pythagoreans have affirmed that he had all his natural philosophy. He dived into the most profound and mysterious secrets of the Pythagoric doctrines; and perceiving other knowledge to be connected with them, he went to Cyrene, where he learned geometry of Theodorus the mathematician. From thence he passed into Egypt, to acquaint himself with the theology of their priests, to study more nicely the proportions of geometry, and to instruct himself in astronomical observations; and having taken a full survey of all the country, he settled for some time in the province of Sais, learning of the wise men there, what they held concerning the universe, whether it had a be-

ginning, whether it moved wholly or in part, &c.; and Pausanias affirms, that he learned from these the immortality, and also the transmigration, of souls. Some of the fathers will have it, that he had communication with the books of Moses, and that he studied under a learned Jew of Heliopolis; but there is nothing that can be called evidence for these assertions. St Austin once believed that Plato had some conference with Jeremiah; but afterwards discovered, that that prophet must have been dead at least 60 years before Plato's voyage to Egypt.

Plato's curiosity was not yet satisfied. He travelled into Persia to consult the magi about the religion of that country: and he designed to have penetrated even to the Indies, and to have learned of the Brachmans their manners and customs; but the wars in Asia hindered him.

"He then returned into Italy, to the Pythagorean school at Tarentum, where he endeavoured to improve his own system, by incorporating with it the doctrine of Pythagoras, as it was then taught by Archytas, Timæus, and others. And afterwards, when he visited Sicily, he retained such an attachment to the Italic school, that, through the bounty of Dionysius, he purchased at a vast price several books which contained the doctrine of Pythagoras, from Philolaus, one of his followers.

"Returning home richly stored with knowledge of various kinds, Plato settled in Athens, and executed the design, which he had doubtless long had in contemplation, of forming a new school for the instruction of youth in the principles of philosophy. The place which he made choice of for this purpose was a public grove, called the *Academy*, from Hecademus, who left it to the citizens for the purpose of gymnastic exercises. Adorned with statues, temples, and sepulchres, planted with lofty plane-trees, and intersected by a gentle stream, it afforded a delightful retreat for philosophy and the muses. Of this retreat Horace speaks:

Atque inter sylvas Academi querere verum,

"Midst Academic groves to search for truth."

Within this inclosure he possessed, as a part of his humble patrimony, purchased at the price of three thousand drachmas, a small garden, in which he opened a school for the reception of those who might be inclined to attend his instructions. How much Plato valued mathematical studies, and how necessary a preparation he thought them for higher speculations, appears from the inscription which he placed over the door of his school: *Οὐδὲς ἀγέμενος εἰσέλθτω*. "Let no one who is unacquainted with geometry enter here."

"This new school soon became famous, and its master was ranked among the most eminent philosophers. His travels into distant countries, where learning and wisdom flourished, gave him celebrity among his brethren of the Socratic sect. None of these had ventured to institute a school in Athens except Aristippus; and he had confined his instructions almost entirely to ethical subjects, and had brought himself into some discredit by the freedom of his manners. Plato alone remained to inherit the patrimony of public esteem which Socrates had left his disciples; and he possessed talents and learning adequate to his design of extending the study of philosophy beyond the limits within which it had been inclosed.

Plato, closed by his master. The consequence was, not only that young men crowded to his school from every quarter, but that people of the first distinction in every department frequented the academy. Even females, disguised in mens clothes, often attended his lectures. Among the illustrious names which appear in the catalogue of his followers are Dion the Syracusan prince, and the orators Hyperides, Lycurgus, Demosthenes, and Isocrates.

Greatness was never yet exempted from envy. The distinguished reputation of Plato brought upon him the hatred of his former companions in the school of Socrates, and they loaded him with detraction and obloquy. It can only be ascribed to mutual jealousy, that Xenophon and he, though they relate the discourses of their common master, studiously avoid mentioning one another. Diogenes the Cynic ridiculed Plato's doctrine of ideas and other abstract speculations. In the midst of these private censures, however, the public fame of Plato daily increased; and several states, among which were the Arcadians and Thebans, sent ambassadors with earnest requests that he would come over, not only to instruct the young men in philosophy, but also to prescribe them laws of government. The Cyrenians, Syracusians, Cretans, and Eleans, sent also to him: he did not go to any of them, but gave laws and rules of governing to all. He lived single, yet soberly and chastly. He was a man of great virtues, and exceedingly affable; of which we need no greater proof, than his civil manner of conversing with the philosophers of his own times, when pride and envy were at their height. His behaviour to Diogenes is always mentioned in his history. The Cynic was vastly offended, it seems, at the politeness and fine taste of Plato, and used to catch all opportunities of snarling at him. He dined one day at his table with other company, and, trampling upon the tapestry with his dirty feet, uttered this brutish sarcasm, "I trample upon the pride of Plato;" to which Plato wisely reparteeed, "With greater pride."

The fame of Plato drew disciples to him from all parts; among whom were Speusippus an Athenian, his sister's son, whom he appointed his successor in the academy, and the great Aristotle.

The admiration of this illustrious man was not confined to the breasts of a few philosophers. He was in high esteem with several princes, particularly Archelaus king of Macedon, and Dionysius tyrant of Sicily. At three different periods he visited the court of this latter prince, and made several bold but unsuccessful attempts to subdue his haughty and tyrannical spirit. A brief relation of the particulars of these visits to Sicily may serve to cast some light upon the character of our philosopher; and we shall give it in the words of Dr Enfield, from whose elegant history of philosophy we have extracted by much the most valuable parts of this article.

"The professed object of Plato's first visit to Sicily, which happened in the 40th year of his age, during the reign of the elder Dionysius the son of Hermocrates, was, to take a survey of the island, and particularly to observe the wonders of Mount Ætna. Whilst he was resident at Syracuse, he was employed in the instruction of Dion, the king's brother-in-law, who possessed excellent abilities, though hitherto restrained by the terrors of a tyrannical government, and relaxed by the luxuries of a licentious court. Disgusted by the debauched manners of the Syracusians, he endeavoured to rescue

his pupil from the general depravity. Nor did Dion disappoint his preceptor's expectations. No sooner had he received a taste of that philosophy which leads to virtue, than he was fired with an ardent love of wisdom. Entertaining an hope that philosophy might produce the same effect upon Dionysius, he took great pains to procure an interview between Plato and the tyrant. In the course of the conference, whilst Plato was discoursing on the security and happiness of virtue, and the miseries attending injustice and oppression, Dionysius, perceiving that the philosopher's discourse was levelled against the vices and cruelties of his reign, dismissed him with high displeasure from his presence, and conceived a design against his life. It was not without great difficulty that Plato, by the assistance of Dion, made his escape. A vessel which had brought over Pollis, a delegate from Sparta, was fortunately at that time returning to Greece. Dion engaged Pollis to take the charge of the philosopher, and land him safely in his native country; but Dionysius discovered the design, and obtained a promise from Pollis, that he would either put him to death or sell him as a slave upon the passage. Pollis accordingly sold him in the island of Ægina; the inhabitants of which were then at war with the Athenians. Plato could not long remain unnoticed: Anicerris, a Cyrenaic philosopher, who happened to be at that time in the island, discovered the stranger, and thought himself happy in an opportunity of showing his respect for so illustrious a philosopher: he purchased his freedom for 30 minæ, or 84l. 10s. Sterling money, and sent him home to Athens. Repayment being afterwards offered to Anicerris by Plato's relations, he refused the money, saying, with that generous spirit which true philosophy always inspires, that he saw no reason why the relations of Plato should engross to themselves the honour of serving him."

After a short interval, Dionysius repented of his ill-placed resentment, and wrote to Plato, earnestly requesting him to repair his credit by returning to Syracuse; to which Plato gave this high-spirited answer, that philosophy would not allow him leisure to think of Dionysius. He was, however, prevailed upon by his friend Dion to accept of the tyrant's invitation to return to Syracuse, and take upon him the education of Dionysius the younger, who was heir apparent to the monarchy. He was received by Dionysius the reigning sovereign with every possible appearance of respect; but after seeing his friend banished, and being himself kept as a prisoner at large in the palace, he was by the tyrant sent back into his own country, with a promise that both he and Dion should be recalled at the end of the war in which the Sicilians were then engaged. This promise was not fulfilled. The tyrant wished for the return of Plato; but could not resolve to recal Dion. At last, however, having probably promised that the philosopher should meet his friend at the court of Syracuse, he prevailed upon Plato to visit that capital a third time. When he arrived, the king met him in a magnificent chariot, and conducted him to his palace. The Sicilians too rejoiced in his return; for they hoped that the wisdom of Plato would at length triumph over the tyrannical spirit of the prince. Dionysius seemed wholly divested of his former resentments, listened with apparent pleasure to the philosopher's doctrine, and, among other expressions of regard, presented him with eighty talents.

Plato.

of gold. In the midst of a numerous train of philosophers, Plato now possessed the chief influence and authority in the court of Syracuse. Whilst Aristippus was enjoying himself in splendid luxury; whilst Diogenes was freely indulging his acrimonious humour; and whilst Æschines was gratifying his thirst after riches;—Plato supported the credit of philosophy with an air of dignity, which his friends regarded as an indication of superior wisdom, but which his enemies imputed to pride. After all, it was not in the power of Plato to prevail upon Dionysius to adopt his system of policy, or to recall Dion from his exile. Mutual distrust, after a short interval, arose between the tyrant and the philosopher; each suspected the other of evil designs, and each endeavoured to conceal his suspicion under the disguise of respect. Dionysius attempted to impose upon Plato by condescending attentions, and Plato to deceive Dionysius by an appearance of confidence. At length, the philosopher became so much dissatisfied with his situation, that he earnestly requested permission to return to Greece, which was at last granted him, and he was sent home loaded with rich presents. On his way to Athens, passing through Elis during the celebration of the Olympic games, he was present at this general assembly of the Greeks, and engaged universal attention.

From this narrative it appears, that if Plato visited the courts of princes, it was chiefly from the hope of seeing his ideal plan of a republic realized; and that his talents and attainments rather qualified him to shine in the academy than in the council or the senate.

Plato, now restored to his country and his school, devoted himself to science, and spent the last years of a long life in the instruction of youth. Having enjoyed the advantage of an athletic constitution, and lived all his days temperately, he arrived at the 81st, or according to some writers the 79th, year of his age, and died, through the mere decay of nature, in the first year of the hundred and eighth Olympiad. He passed his whole life in a state of celibacy, and therefore left no natural heirs, but transferred his effects by will to his friend Adiamantus. The grove and garden, which had been the scene of his philosophical labours, at last afforded him a sepulchre. Statues and altars were erected to his memory; the day of his birth long continued to be celebrated as a festival by his followers; and his portrait is to this day preserved in gems: but the most lasting monuments of his genius are his writings, which have been transmitted, without material injury, to the present times.

The character of this philosopher has always been high. Besides the advantages of a noble birth, he had a large and comprehensive understanding, a vast fund of wit and good taste, great evenness and sweetness of temper, all cultivated and refined by education and travel; so that it is no wonder if he was honoured by his countrymen, esteemed by strangers, and adored by his scholars. The ancients thought more highly of Plato than of all their philosophers: they always called him the *Divine Plato*; and they seemed resolved that his descent should be more than human. "There are (says Apuleius) who assert Plato to have sprung from a more sublime conception; and that his mother Perictione, who was a very beautiful woman, was impregnated by Apollo in the shape of a spectre." Plutarch, Suidas,

and others, affirm this to have been the common report at Athens. When he was an infant, his father Ariston went to Hymettus, with his wife and child, to sacrifice to the muses; and while they were busied in the divine rites, a swarm of bees came and distilled their honey upon his lips. This, says Tully, was considered as a presage of his future eloquence. Apuleius relates, that Socrates, the night before Plato was recommended to him, dreamed that a young swan fled from Cupid's altar in the academy, and settled in his lap; thence soared to heaven, and delighted the gods with its music: and when Ariston the next day presented Plato to him, "Friends (says Socrates), this is the swan of Cupid's academy." The Greeks loved fables: they show however in the present case, what exceeding respect was paid to the memory of Plato. Tully perfectly adored him; tells us, how he was justly called by Panætius the *divine*, the *most wise*, the *most sacred*, the *Homer of philosophers*; intitled him to Atticus, *Deus ille postor*; thinks, that if Jupiter had spoken Greek, he would have spoken in Plato's language; and made him so implicitly his guide in wisdom and philosophy, as to declare, that he had rather err with Plato than be right with any one else. But, pænegyric aside, Plato was certainly a very wonderful man, of a large and comprehensive mind, an imagination infinitely fertile, and of a most flowing and copious eloquence. Nevertheless, the strength and heat of fancy prevailing in his composition over judgment, he was too apt to soar beyond the limits of earthly things, to range in the imaginary regions of general and abstracted ideas; and on which account, though there is always a greatness and sublimity in his manner, he did not philosophize so much according to truth and nature as Aristotle, though Cicero did not scruple to give him the preference.

The writings of Plato are all in the way of dialogue; where he seems to deliver nothing from himself, but every thing as the sentiments and opinions of others, of Socrates chiefly, of Timæus, &c. He does not mention himself anywhere, except once in his *Phædo*, and another time in his *Apology* for Socrates. His style, as Aristotle observed, is betwixt prose and verse: on which account, some have not scrupled to rank him with the poets. There is a better reason for so doing than the elevation and grandeur of his style: his matter is oftentimes the offspring of imagination, instead of doctrines or truths deduced from nature. The first edition of Plato's works in Greek was put out by Aldus at Venice in 1513; but a Latin version of him by Marfilus Ficinus had been printed there in 1491. They were reprinted together at Lyons in 1588, and at Francfort in 1602. The famous printer Henry Stephens, in 1578, gave a most beautiful and correct edition of Plato's works at Paris, with a new Latin version by Serranus, in three volumes folio; and this deservedly passes for the best edition of Plato: yet Serranus's version is very exceptionable, and in many respects, if not in all, inferior to that of Ficinus.

PLATONIC, something that relates to Plato, his school-philosophy, opinions, or the like. Thus, platonic love denotes a pure spiritual affection, for which Plato was a great advocate, subsisting between the different sexes, abstracted from all carnal appetites, and regarding no other object but the mind and its beauties;

phic,
anism.

or it is even a sincere disinterested friendship subsisting between persons of the same sex, abstracted from any selfish views, and regarding no other object than the person, if any such love or friendship has aught of a foundation in nature.

PLATONIC Year, or the *Great Year*, is a period of time determined by the revolution of the equinoxes, or the space wherein the stars and constellations return to their former places, in respect of the equinoxes. The platonian year, according to Tycho Brahe, is 25816, according to Ricciolus 25920, and according to Cassini 24800 years.

This period once accomplished, it was an opinion among the ancients that the world was to begin anew, and the same series of things to turn over again.

PLATONISM, the philosophy of Plato, which was divided into three branches, *theology*, *physics*, and *mathematics*. Under *theology* was comprehended metaphysics and ethics, or that which in modern language is called *moral philosophy*. Plato wrote likewise on *dialectics*, but with such inferiority to his pupil Aristotle, that his works in that department of science are seldom mentioned.

The ancient philosophers always began their theological systems with some disquisition on the nature of the gods, and the formation of the world; and it was a fundamental doctrine with them, that *from nothing nothing can proceed*. We are not to suppose that this general axiom implied nothing more than that for every effect there must be a cause; for this is a proposition which no man will controvert who understands the terms in which it is expressed: but the ancients believed that a proper creation is impossible even to Omnipotence, and that to the production of any thing a *material* is not less *necessary* than an *efficient* cause, (see *METAPHYSICS*, n° 264, 304.) That with respect to this important question, Plato agreed with his predecessors and contemporaries, appears evident to us from the whole tenor of his

ist. of

Timæus. We agree with Dr Enfield § in thinking, that in this dialogue, which comprehends his whole doctrine on the subject of the formation of the universe, matter is so manifestly spoken of as eternally co-existing with God, that this part of his doctrine could not have been mistaken by so many learned and able writers, had they not been seduced by the desire of establishing a coincidence of doctrine between the writings of Plato and Moses. It is certain that neither Cicero ‡, nor Apuleius ||, nor Alcinoüs †, nor even the later commentator Chalcidius, understood their master in any other sense than as admitting two primary and incorruptible principles, God and matter; to which we shall afterwards see reason to add a third, namely ideas. The passages quoted by those who maintain the contrary opinion are by no means sufficient for their purpose. Plato, it is true, in his *Timæus*, calls God the *parent of the universe*, and in his *Sophista* speaks of him as “forming animate and inanimate beings, which did not before exist:” but these expressions do not necessarily imply that this offspring of Deity was produced from nothing, or that no prior matter existed from which these new beings were formed. Through the whole dialogue of the *Timæus*, Plato supposes two eternal and independent causes of all things; one, that by which all things are made, which is God; the other, that from which all things are made, which is matter. He distinguishes between God,

matter, and the universe, and supposes the Architect of *Platonism*. the world to have formed it out of a mass of pre-existent matter. Matter, according to Plato, is an eternal and infinite principle. His doctrine on this head is thus explained by Cicero ‡. “Matter, from which all things are produced and formed, is a substance without form or quality, but capable of receiving all forms, and undergoing every kind of change; in which, however, it never suffers annihilation, but merely a solution of its parts, which are in their nature infinitely divisible, and move in portions of space which are also infinitely divisible. When that principle which we call quality is moved, and acts upon matter, it undergoes an entire change, and those forms are produced, from which arises the diversified and coherent system of the universe.” This doctrine Plato unfolds at large in his *Timæus*, and particularly insists upon the notion, that matter has originally no form, but is capable of receiving any. He calls it the mother and receptacle of forms, by the union of which with matter the universe becomes perceptible to the senses; and maintains, that the visible world owes its forms to the energy of the divine intellectual nature.

Our author is supported in drawing this inference by the testimony of Diogenes Laertius, who surely understood the language and dogmas of Plato better than the most accomplished modern scholar can pretend to do; yet a learned writer † has lately expressed great surprise that any one should consider matter as having been, in

Dr Ogilvie.

Plato's opinion, uncreated; and he boldly affirms, that Laertius, instead of asserting that spirit and matter were the principles of all things, ought to have said that God alone, in Plato's estimation, was their original.—To prove this, he gives from the *Timæus* a quotation, in which the founder of the Academy declares that God framed heaven and earth, and the inferior deities; and that as he *fashioned*, so he pervades all nature. He observes, that Cicero denominates the god of Plato the *maker*, and the god of Aristotle only the *governor*, of the world. And, to satisfy those who may demand a particular proof of Plato's having taught a real creation, he affirms that his writings abound with declarations on the subject, of which the meaning cannot be misapprehended. “With this purpose (says he) Plato denominates at one time the principles or substance of all things, *τινὸν κατὰ θεὸν ἀναμειγγύον*, the productions of the efficient Deity, and at others enters more particularly into the question. Thus, he observes, that many persons are ignorant of the nature and power of mind or intellect, ‘as having existed at the beginning, antecedent to all bodies.’ Of this mind, he observes, that it is without exception *παντὸς πρῶτον*, of all things the most ancient; and he subjoins, in order to remove all doubt of his purpose, that it is also *ἀρχὴ κινήσεως*, the cause or principle of motion.”

Theology of Plato.

With all possible respect for Dr Ogilvie, of whose piety and erudition we are thoroughly convinced, we must take the liberty to say, that to us the declarations of Plato on this subject appear much less precise and explicit than they appear to him; and that the inference which he would draw from the words of Cicero seems not to flow necessarily from the sense of those words. That Plato believed God to have framed the heaven and the earth, and to have fashioned all nature, is a position which, as far as we know, has never been controverted; but between *framing* or *fashioning* the chaos or *ἄλυσιν*, and calling the universe into existence from non-

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entity,

Platonism. entity, there is an infinite and an obvious difference. The distinction made by Cicero between the God of Plato and the God of Aristotle is a just distinction, but it will not bear the superstructure which the learned Doctor builds upon it. Aristotle maintained the eternity of the world in its present form. Plato certainly taught that the first matter was in time reduced from a chaotic state into *form* by the power of the Demiurgus; but we have seen nothing in his writings which explicitly declares his belief that the *first matter* was itself created.

The learned Cudworth, who wished, like Dr Ogilvie, to find a coincidence of doctrine between the theology of Plato and that of the Gospel, strained all his faculties to prove that his favourite philosopher taught a proper creation; but he laboured in vain. He gives a number of quotations in support of his position; of which we shall here insert only those two upon which Dr Ogilvie seems to lay the greatest stress. Plato, says the author of the Intellectual System, calls the one God (A) ὁς γὰρ οὐρανόθεν καὶ βίους, καὶ πάντα τὰ ἐν οὐρανῷ καὶ τὰ ἐν ἄδου, καὶ ὑπὸ γῆς ἀπαντὰ ἐργασίαι—He that makes earth, and heaven, and the gods, and doth all things both in heaven, and hell, and under the earth. And, again, “he by whose efficiency the things of the world (ὁσπερ οὐκ οὐκ) were afterwards made when they were not before*.” Both Cudworth and Ogilvie think this last sentence an explicit declaration of Plato’s belief in the creative power of God: but that they are mistaken has been evinced by Mosheim with a force of argument which will admit of no reply. In that part of the *Sophist* from which the quotation is taken, Plato considers the *δυναμὴν ποιητικὴν*, of which he is treating, as belonging both to God and to man; and he defines it in general to be “a certain power which is the cause that things may afterwards be which were not before.” Cudworth wishes to confine this definition to the divine power; and adds from himself to the text which he quotes the following words, which are not in Plato, OR FROM AN ANTECEDENT NON-EXISTENCE BROUGHT FORTH INTO BEING! That the incomparable author intended to deceive his reader, we are far from imagining: his zeal for Platonism had deceived himself. Plato’s definition comprehends the *δυναμὴν ποιητικὴν* † as well of man as of God; and therefore cannot infer a creative power anywhere, unless the father of the academy was so very absurd as to suppose human artists the creators of those machines which they have invented and made! Mosheim thinks that Cudworth was misled by too implicit a confidence in *Ficinus*; and it is not impossible that Dr Ogilvie may have been swayed by the authority, great indeed, of the author of the Intellectual System.

That intellect existed antecedent to all bodies is indeed a Platonic dogma, from which Dr Ogilvie, after Cudworth, wishes to infer that the doctrine of the crea-

tion was taught in the academy; but Dr Ogilvie knows, Platonism and no man knew better than Cudworth, that Plato, with every other Greek philosopher, distinguished between *body* and *matter*; and that though he held the priority of intellect to the former, it by no means follows that he believed it to have existed antecedent to the latter. That he believed *mind*, or rather *soul* (for he distinguishes between the two), to be the cause or principle of motion, cannot be denied; but we are not therefore authorised to conclude that he likewise believed it to be the cause of the existence of matter. That he believed mind to be the most ancient of *all things*, taking the word *things* in the most absolute sense, cannot be true, since by Dr Ogilvie’s own acknowledgment he held the existence and eternity of *ideas*, not to add that he believed τὸ ἐν or τ’ ἀγαθόν—the first hypostasis in his trinity, to be superior to mind and prior to it, though not in time, yet in the order of nature. When therefore he calls mind the most ancient of *all things*, he must be supposed to mean only that it is more ancient than *all bodies* and inferior souls. It is no reflection on the character of Plato that he could not, by the efforts of his own reason, acquire any notion of a proper creation; since we, who have the advantage of his writings, and of writings infinitely more valuable, to instruct us, find it extremely difficult, if not impossible, to conceive how any thing can begin to be. We believe the fact on the authority of revelation; but should certainly have never agitated such a question, had it not been stated to us by writers inspired with celestial wisdom.

In the Platonic cosmogony we cannot therefore doubt but that the eternity of the *ὄντι πρῶτῳ* was taken for granted. Whether it was an eternal and necessary emanation from an eternal mind, is not perhaps quite so evident, though our own opinion is, that it was believed to be self-existent. But be this as it may, which is not worth disputing, one thing is certain, that Plato did not believe it to have a single form or quality which it did not receive either from the *Demiurgus* or the *Psyche*—the second or third person of his trinity. Except Aristotle, all the Greek philosophers, who were not materialists, held nearly the same opinions respecting the origin of the world; so that in examining their systems we shall be greatly misled if we understand the terms *incorporeal* and *immaterial* as at all synonymous. It was also a doctrine of Plato, that there is in matter a necessary but blind and refractory force; and that hence arises a propensity in matter to disorder and deformity, which is the cause of all the imperfection which appears in the works of God, and the origin of evil. On this subject Plato writes with wonderful obscurity: but, as far as we are able to trace his conceptions, he appears to have thought, that matter, from its nature, resists the will of the Supreme Artificer, so that he cannot perfectly execute his designs; and that this is the cause of the

* *Sophista*, p. 168.

† *Mosch.*
ed. Cud.
Syst. Intel.
cap. 4. § 23.
n. 11.

(A) Mosheim affirms that this quotation is nowhere to be found in the writings of Plato. He therefore at first suspected that the learned author, in looking hastily over Plato’s 10th book *De Legibus*, had transferred to God what is there said of the *anima mundi*, leading by its own motions every thing in the heaven, the earth, and the sea, and that he had added something of his own. He dropped that opinion, however, when he found Plato, in the 10th book of his *Republic*, declaring it to be as “easy for God to produce the sun, moon, stars, and earth, &c. from himself, as it is for us to produce the image of ourselves, and whatever else we please, only by interposing a looking-glass.” In all this power, however, there is nothing similar to that of creation.

the mixture of good and evil which is found in the material world.

Plato, however, was no materialist. He taught, that there is an intelligent cause, which is the origin of all spiritual being, and the former of the material world. The nature of this great being he pronounced it difficult to discover, and when discovered impossible to divulge. The existence of God he inferred from the marks of intelligence, which appear in the form and arrangement of bodies in the visible world: and from the unity of the material system he concluded, that the mind by which it was formed must be one. God, according to Plato, is the supreme intelligence, incorporeal, without beginning, end, or change, and capable of being perceived only by the mind. He certainly distinguished the Deity not only from body, and whatever has corporeal qualities, but from matter itself, from which all things are made. He also ascribed to him all those qualities which modern philosophers ascribe to immaterial substance; and conceived him to be in his nature simple, unincircumscribed in space, the author of all regulated motion, and, in fine, possessed of intelligence in the highest perfection.

His notions of God are indeed exceedingly refined, and such as it is difficult to suppose that he could ever have acquired but from some obscure remains of primeval tradition, gleaned perhaps from the priests of Egypt or from the philosophers of the East. In the Divine Nature he certainly believed that there are two, and probably that there are three, *hypostases*, whom he called *το ον* and *το εν*, *νους* and *ψυχη*. The first he considered as self-existent, and elevated far above all mind and all knowledge; calling him, by way of eminence, *the being*, or *the one*. The only attribute which he acknowledged in this person was goodness; and therefore he frequently styles him *το αγαθον*—the good, or *essential goodness*. The second he considered as mind, the *wisdom* or *reason* of the first, and the *maker of the world*; and therefore he styles him *νους*, *λογος*, and *δημιουργος*. The third he always speaks of as the *soul of the world*; and hence calls him *ψυχη*, or *ψυχη του κοσμου*. He taught that the *second* is a necessary emanation from the *first*, and the *third* from the *second*, or perhaps from the *first* and *second*.

Some have indeed pretended, that the *Trinity*, which is commonly called *Platonic*, was a fiction of the later Platonists, unknown to the founder of the school: but any person who shall take the trouble to study the writings of Plato, will find abundant evidence that he really asserted a triad of divine hypostases, all concerned in the formation and government of the world. Thus in his 10th book of *Laws*, where he undertakes to prove the existence of a Deity in opposition to atheists, he ascends no higher in the demonstration than to the *ψυχη* or mundane soul, which he held to be the immediate and proper cause of all the motion that is in the world. But in other parts of his writings he frequently asserts, as superior to the self-moving principle, an immovable *νους* or intellect, which was properly the *demurgus* or fram-mer of the world; and above this *hypostasis* one most

simple and absolutely perfect being, who is considered in his *Theology* as *αυτοθεος*, the *original deity*, in contradistinction from the others, who are only *θεοι εκ βου*. These doctrines are to be gathered from his works at large, particularly from the *Timæus*, *Phædrus*, *Sophista*, and *Epinomis*: but there is a passage in his second epistle to Dionysius, apparently written in answer to a letter in which that monarch had required him to give a more explicit account than he had formerly done of the nature of God, in which the doctrine of a Trinity seems to be directly asserted. "After having said that he meant to wrap up his meaning in such obscurity, as that an adept only should fully comprehend it, he adds expressions to the following import: 'The Lord of Nature is surrounded on all sides by his works: whatever is, exists by his permission: he is the fountain and source of excellence: around the second person are placed things of the second order; and around the third those of the third degree (B).'" Of this obscure passage a very satisfactory explanation is given in Dr Ogilvie's *Theology of Plato*, to which the narrow limits prescribed to such articles as this compel us to refer the reader. We shall only say, that the account which we have given of the Platonic Trinity is ably supported by the Doctor.

In treating of the eternal emanation of the second and third Hypostases from the first, the philosophers of the academy compare them to light and heat proceeding from the sun. Plato himself, as quoted by Dr Cudworth, illustrates his doctrine by the same comparison. For "*ἡ ἀρχή*", or the first hypostasis, is in the intellectual world the same (he says) to intellect and intelligibles that the sun is in the corporeal world to vision and visibles; for as the sun is not vision itself but the cause of vision, and as that light by which we see is not the sun but only a thing like the sun; so neither is the Supreme or Highest Good properly knowledge, but the cause of knowledge; nor is intellect, considered as such, the best and most perfect being, but only a being having the form of perfection." Again, "as the sun causes other things not only to become visible but also to be generated; so the Supreme Good gives to things not only their capability of being known, but also their very essences by which they subsist; for this fountain of the Deity, this highest good, is not itself properly essence, but above essence, transcending it in respect both of dignity and of power."

The resemblance which this trinity of Plato bears to that revealed in the gospel must be observed by every attentive reader; but the two doctrines are likewise in some respects exceedingly dissimilar. The third hypostasis in the Platonic system appears in no point of view co-ordinate with the first or second. Indeed the first is elevated far above the second, and the third sunk still farther beneath it, being considered as a mere soul immersed in matter, and forming with the corporeal world, to which it is united, one compound animal. Nay, it does not appear perfectly clear, that Plato considered his *ψυχη του κοσμου* as a pure spirit, or as having subsisted from eternity as a distinct *Hypostasis*. "This governing spirit, of whom the earth, properly so called, is the

(B) "Περὶ τῶν πάντων θεῶν, αὐτὸς ὁ θεὸς, καὶ ἐκ τούτου πάντα. Ἐκείνους ποιεῖ τὰ πάντα τὰ ἄλλα. Αὐτὸς γὰρ δὲ πρὸς τὰς ἀνθρώπων, καὶ τῶν τετράων." Οἶον. p. 1. 69.

Platonist body, consisted, according to our author's philosophy, of the same and the other; that is, of the first matter, and of pure intelligence, framed to actuate the machinery of nature. The Supreme Being placed him in the middle of the earth; which, in the vivid idea of Plato, seemed itself to live, in consequence of an influence that was felt in every part of it. From this feat his power is represented as being extended on all sides to the utmost limit of the heavens; conferring life, and preserving harmony in the various and complicated parts of the universe. Upon this being God is said to have looked with peculiar complacency after having formed him as an image of himself, and to have given beauty and perfect proportion to the mansion which he was destined to occupy. According to the doctrine of Timæus, the Supreme Being struck out from this original mind innumerable spirits of inferior order, endowed with principles of reason; and he committed to divinities of secondary rank the task of investing these in material forms, and of dispersing them as inhabitants of the sun, moon, and other celestial bodies. He taught also, that at death the human soul is reunited to the *ψυχή του κόσμου*, as to the source from which it originally came."

Such is the third person of the Platonic triad, as we find his nature and attributes very accurately stated by Dr Ogilvie; and the Christian philosopher, who has no particular system to support, will not require another proof that the triad of Plato differs exceedingly from the Trinity of the Scriptures. Indeed the third hypostasis in this triad has so much the appearance of all that the ancients could mean by that which we call a *creature*, that the learned Cudworth, who wished, it is difficult to conceive for what reason, to find the sublimest mystery of the Christian faith explicitly taught in the writings of a pagan philosopher, was forced to suppose that Plato held a double *ψυχή* or soul, one *ἐγκοσμίου* incorporated with the material world, and the other *ὑπερκοσμίου* or *supramundane*, which is not the soul but the governor of the universe. We call this a mere hypothesis; for though the author displays vast erudition, and adduces many quotations in which this double *psyche* is plainly mentioned, yet all those quotations are taken from Platonists who lived after the propagation of the gospel, and who, calling themselves *ecclesiastics*, freely stole from every sect such dogmas as they could incorporate with their own system, and then attributed those dogmas to their master. In the writings of Plato himself, there is not so much as an allusion to this supramundane *psyche**; and it is for this reason (the *ψυχή*, of which he treats being so very inferior to the *δemiουργός* and *αἰτία*) that we have expressed with hesitation his belief of *three* hypostases in the divine nature. Yet that he did admit so many, seems more than probable both from the passage illustrated by Dr Ogilvie and from the attempt of Plotinus, one of his followers, to demonstrate that the number can be neither greater nor less. That his doctrine on this subject should be inaccurate and erroneous, can excite no wonder; whilst it must be confessed to have such a resemblance to the truth, and to be so incapable of being proved by reasoning from effects to causes, that we could not doubt of his having inherited it by tradition, even though we had not complete evidence that something very similar to it was taught long before him, not only by Pythagoras and Parmenides, but by the philosophers of the east.

* Mosb.
ed. Cud.
Syst. Intel
c. 4. § 36.
n. 43.

We have said that the Demiurgus was the maker of the world from the first matter which had existed from eternity; but in Plato's cosmogony there is another principle, more mysterious, if possible, than any thing which we have yet mentioned. This is his intellectual system of *ideas*, which it is not easy to collect from his writings, whether he considered as *independent* existences, or only as archetypal forms, which had subsisted from eternity in the *λογος* or divine intellect. On this subject he writes with such exceeding obscurity, that men of the first eminence, both among the ancients and the moderns, have differed about his real meaning. Some have supposed, that by *ideas* he meant real beings subsisting from eternity, independent of all minds, and separate from all matter; and that of these ideas he conceived some to be living and others to be without life. In this manner his doctrine is interpreted by Tertulian* among the ancients, and by the celebrated Bruck-† among the moderns; and not by them only, but by many others equally learned, candid, and acute. Cudworth, on the other hand, with his annotator Mosheim, contend, that by his ideal world Plato meant nothing more than that there existed from eternity in the *λογος* or mind of God a notion or conception of every thing which was in time to be made. This is certainly much more probable in itself, than that a man of enlarged understanding should have supposed, that there are somewhere in extramundane space real living incorporeal beings eating and drinking, which are the *ideas* of all the animals which ever have been or ever will be eating and drinking in this world. Yet Mosheim candidly acknowledges, that if the controversy were to be decided by the votes of the learned, he is doubtful whether it would be given for or against him; and Cudworth, though he pleads the cause of his master with much ingenuity, owns, that on this subject his language cannot be vindicated. This indeed is most true; for Plato contends, that his ideas are not only the objects of science, but also the proper or physical causes of all things here below; that the *idea* of similitude is the cause of the resemblance between two globes; and the *idea* of dissimilitude the cause that a globe does not resemble a pyramid: he likewise calls them *εἰδή*, *essences* or *substances*, and many of his followers have pronounced them to be *animals*.

These wonderful expressions incline us to adopt with some hesitation the opinion stated by Dr Enfield. This historian of philosophy having observed, that some of the admirers of Plato contend, that by ideas existing in the reason of God, nothing more is meant than conceptions formed in the Divine mind, controverts this opinion with much effect. "By ideas, Plato (says he) appears to have meant something much more mysterious; namely, patterns or archetypes subsisting by themselves, as real beings, *οὕτως οὐτως* in the Divine reason, as in their original and eternal region, and issuing thence to give form to sensible things, and to become objects of contemplation and science to rational beings. It is the doctrine of the Timæus, that ὁ λογισμὸς τοῦ Θεοῦ, the reason of God, comprehends exemplars of all things, and that this reason is one of the primary causes of things. Plutarch says, that Plato supposes three principles, God, Matter, and Idea. Justin Martyr, Pseudo-Origen, and others, assert the same thing.

"That this is the true Platonic doctrine of ideas will appear

Platonism. appear probable, if we attend to the manner in which Plato framed his system of opinions concerning the origin of things. 'Having been from his youth (says Aristotle) conversant with Cratylus, a disciple of Heraclitus, and instructed in the doctrine of that school, that all sensible things are variable, and cannot be proper objects of science, he reasonably concluded, that if there be any such thing as science, there must exist, besides sensible objects, certain permanent natures, perceptible only by the intellect.' Such natures, divine in their origin, and eternal and immutable in their existence, he admitted into his system, and called them *ideas*. Visible things were regarded by Plato as fleeting shades, and ideas as the only permanent substances. These he conceived to be the proper objects of science to a mind raised by divine contemplation above the perpetually varying scenes of the material world."

It was a fundamental doctrine in the system of Plato, that the Deity formed the material world after a perfect model, consisting of those ideas which had eternally subsisted in his own reason; and yet, with some appearance of contradiction, he calls this model "*self-existent, indivisible, and eternally generated*." Nay, he talks of it as being intelligent as well as eternal, and wholly different from the transcripts, which are subjected to our inspection. There is so much mystery, confusion, and apparent absurdity, in the whole of this system, as it has come down to us, that we must suppose the friends of Plato to have been intrusted with a key to his esoteric doctrines, which has long been lost, otherwise it would be difficult to conceive how that philosopher could have had so many admirers.

With almost every ancient theist of Greece the founder of the academy believed in an order of beings called *dæmons*, which were superior to the souls of men, and struck off by the Demiurgus from the soul of the world. Of these the reader will find some account elsewhere: (See *DÆMON* and *POLYTHEISM*). We mention them at present because they make an important appearance in Plato's system of physics, which was built upon them and upon the doctrine which has been stated concerning God, matter, and ideas. He taught, that the visible world was formed by the Supreme Architect, uniting eternal and immutable ideas to the first matter; that the universe is one animated being*, including within its limits all animated natures; that, in the formation of the visible and tangible world, fire and earth were first formed, and were afterwards united by means of air and water; that from perfect parts one perfect whole was produced, of a spherical figure, as most beautiful in itself, and best suited to contain all other figures†; that the elementary parts of the world are of regular geometrical forms, the particles of earth being cubical, those of fire pyramidal, those of air in the form of an octohedron, and those of water in that of an icosahedron; that these are adjusted in number, measure, and power, in perfect conformity to the geometrical laws of proportion; that the soul which pervades this sphere is the cause of its revolution round its centre; and, lastly, that the world will remain for ever, but that by the action of its animating principle, it accomplishes certain periods, within which every thing returns to its ancient place and state. This periodical revolution of nature is called the *Platonic* or *great year*. See the preceding article.

Tim.

Ibid.

The metaphysical doctrines of Plato, which treat of Platonism. the human soul, and the principles of his system of ethics, have been detailed in other articles (See *METAPHYSICS*, Part III. chap. iv.; and *MORAL Philosophy*, n° 6.): but it is worthy of observation in this place, that, preparatory to the study of all philosophy, he required from his disciples a knowledge of the elements of mathematics. In his Republic, he makes Glaucus, one of the speakers, recommend them for their usefulness in human life. "Arithmetic for accounts and distributions; geometry for incampments and mensurations; music for solemn festivals in honour of the gods; and astronomy for agriculture, for navigation, and the like. Socrates, on his part, denies not the truth of all this, but still insinuates that they were capable of answering an end more sublime. 'You are pleasant (says he) in your seeming to fear the multitude, lest you should be thought to enjoin certain sciences that are useless. 'Tis indeed no contemptible matter, though a difficult one, to believe, that through these particular sciences the soul has an organ purified and enlightened, which is destroyed and blinded by studies of other kinds; an organ better worth saving than a thousand eyes, in as much as *truth* becomes visible through *this alone*.'"

"Concerning policy, Plato has written at large in his Republic and in his Dialogue on Laws. He was so much enamoured with his own conceptions on this subject, that it was chiefly the hope of having an opportunity to realize his plan of a republic which induced him to visit the court of Dionysius. But they who are conversant with mankind, and capable of calmly investigating the springs of human actions, will easily perceive that his projects were chimerical, and could only have originated in a mind replete with philosophical enthusiasm. Of this nothing can be a clearer proof than the design of admitting in his republic a community of women, in order to give reason an entire controul over desire. The main object of his political institutions appears to have been, the subjugation of the passions and appetites, by means of the abstract contemplation of ideas. A system of policy, raised upon such fanciful grounds, cannot merit a more distinct consideration."

Such is genuine Platonism as it was taught in the old academy by the founder of the school and his immediate followers; but when Arcefilaus was placed at the head of the academicks, great innovations were introduced both into their doctrines and into their mode of teaching (See *ARCESILAUS*). This man was therefore considered as the founder of what was afterwards called the *middle academy*. Being a professed sceptic, he carried his maxim of uncertainty to such a height, as to alarm the general body of philosophers, offend the governors of the state, and bring just odium upon the very name of the academy. At length *Carneades*, one of the disciples of this school, relinquishing some of the more obnoxious tenets of Arcefilaus, founded what has been called the *new academy* with very little improvement on the principles of the middle. See *CARNEADES*.

Under one or other of these forms Platonism found its way into the Roman republic. Cicero was a Platonist, and one of the greatest ornaments of the school. A school of Platonists was likewise founded in Alexandria in the second century of the Christian era; but their doctrines differed in many particulars from those taught in

Plautus
||
Play-house.

in the three academies. They professed to seek truth wherever they could find it, and to collect their dogmas from every school. They endeavoured to bend some of the principles of Plato into a conformity with the doctrines of the gospel; and they incorporated with the whole many of the maxims of Aristotle and Zeno, and not a few of the fictions of the east. Their system was therefore extremely heterogeneous, and seldom so rational as that of the philosopher after whose name they were called, and of whose doctrines we have given so copious a detail. See AMMONIUS, ECCLECTICS, and PLOTINUS.

PLAUTUS (Marcus Accius), a comic writer of ancient Rome, born at Umbria, a province of Italy. His proper name was *Marcus Accius*, and he is supposed to have acquired the surname of *Plautus* from having splay feet. His parentage appears to have been mean; so that some have thought he was the son of a slave. Aulus Gellius says that Plautus was distinguished for his poetry on the theatre, and Cato for his eloquence in the Forum, at the same time; and observes elsewhere from Varro, that he was so well paid for his plays as to double his stock in trading, in which he lost all he gained by the muses. He is said to have been reduced to work at a mill for his subsistence; but Varro adds, that his wit was his best support, as he composed three of his plays during this drudgery. He died in the first year of the elder Cato's censorship, about the year of Rome 569, and 184 B. C. We have 20 of his plays extant, though not all of them entire. Five of them, comedies, have been elegantly translated into English by Mr B. Thornton, and published in 2 vols 8vo, 1767.

PLAYS. See PLAY-HOUSE.

PLAY-HOUSE. See THEATRE, AMPHITHEATRE, &c. The most ancient English play-houses were the Curtain in Shoreditch and the Theatre. In the time of Shakespeare, who commenced a dramatic writer in 1592, there were no less than 10 theatres open. Four of these were private houses, viz. that in Blackfriars, the Cockpit or Phoenix in Drury-Lane, a theatre in Whitefriars, and one in Salisbury court. The other six were called public theatres, viz. the Globe, the Swan, the Rose, and the Hope, on the Bank-side; the Red Bull, at the upper end of St John's-street, and the Fortune in White-cross Street. The two last were chiefly frequented by citizens. Mr Malone gives us a pretty copious account of these play-houses, in a supplement to his last edition of Shakespeare, which we shall here insert.

"Moll, if not all (says he) of Shakespeare's plays were performed either at the Globe or at the Theatre in Blackfriars. It appears that they both belonged to the same company of comedians, viz. his majesty's servants, which title they assumed, after a licence had been granted to them by King James in 1603, having before that time been called the servants of the lord chamberlain.

"The theatre in Blackfriars was a private house; but the peculiar and distinguishing marks of a private play-house it is not easy to ascertain. It was very small, and plays were there usually represented by candle-light. The Globe, situated on the southern side of the river Thames, was a hexagonal building, partly open to the weather, partly covered with reeds. It was a public

theatre, and of considerable size, and there they always acted by day-light. On the roof of the Globe, and the other public theatres, a pole was erected, to which a flag was affixed. These flags were probably displayed only during the hours of exhibition; and it should seem from a passage in one of the old comedies that they were taken down during Lent, in which season no plays were presented. The Globe, though hexagonal at the outside, was probably a rotunda within, and perhaps had its name from its circular form. It might, however, have been denominated only from its sign, which was a figure of Hercules supporting the Globe. This theatre was burnt down in 1613, but it was rebuilt in the following year, and decorated with more ornament than had been originally bestowed upon it. The exhibitions at the Globe seem to have been calculated chiefly for the lower class of people; those at Blackfriars for a more select and judicious audience.

"A writer informs us, that one of these theatres was a winter and the other a summer house. As the Globe was partly exposed to the weather, and they acted there usually by day-light, it was probably the summer theatre. The exhibitions here seem to have been more frequent than at Blackfriars, at least till the year 1604 or 1605, when the Bank-side appears to have become less fashionable and less frequented than it formerly had been. Many of our ancient dramatic pieces were performed in the yards of carriers inns; in which, in the beginning of queen Elizabeth's reign, the comedians, who then first united themselves in companies, erected an occasional stage. The form of these temporary play-houses seems to be preserved in our modern theatre. The galleries are in both ranged over each other on three sides of the building. The small rooms under the lowest of these galleries answer to our present boxes; and it is observable that these, even in theatres which were built in a subsequent period expressly for dramatic exhibitions, still retained their old name, and are frequently called rooms by our ancient writers. The yard bears a sufficient resemblance to the pit, as at present in use. We may suppose the stage to have been raised in this area, on the fourth side, with its back to the gateway of the inn, at which the money for admission was taken. Hence, in the middle of the Globe, and I suppose of the other public theatres, in the time of Shakespeare, there was an open yard or area, where the common people stood to see the exhibition; from which circumstance they are called by our author groundlings, and by Ben Jonson 'the understanding gentlemen of the ground.'

"In the ancient play-houses there appears to have been a private box, of which it is not easy to ascertain the situation. It seems to have been placed at the side of the stage towards the rear, and to have been at a lower price: in this some people sat, either from economy or singularity. The galleries, or scaffolds as they are sometimes called, and that part of the house which in private theatres was named the pit, seem to have been at the same price; and probably in houses of reputation, such as the Globe, and that in Blackfriars, the price of admission into those parts of the theatre was 6 d. while in some meaner play-houses it was only 1 d. in others only 2 d. The price of admission into the best rooms or boxes was, I believe, in our author's time, 1 s.; though after-

who afterwards it appears to have risen to 2 s. and half-a-crown.

"From several passages in our old plays, we learn, that spectators were admitted on the stage, and that the critics and wits of the time usually sat there. Some were placed on the ground; others sat on stools, of which the price was either 6 d. or 1 s. according, I suppose, to the commodiousness of the situation; and they were attended by pages, who furnished them with pipes and tobacco, which was smoked here as well as in other parts of the house; yet it should seem that persons were suffered to sit on the stage only in the private play-houses, such as Blackfriars, &c. where the audience was more select, and of a higher class; and that in the Globe and other public theatres no such licence was permitted.

"The stage was strewn with rushes, which, as we learn from Hentzner and Caius de Ephemera, was, in the time of Shakespeare, the usual covering of floors in England. The curtain which hangs in the front of the present stage, drawn up by lines and pulleys, though not a modern invention, for it was used by Inigo Jones in the masques at court, was yet an apparatus to which the simple mechanism of our ancient theatres had not arrived, for in them the curtains opened in the middle, and were drawn backwards and forwards on an iron rod. In some play-houses they were woollen, in others made of silk.—Towards the rear of the stage there appears to have been a balcony, the platform of which was probably eight or ten feet from the ground. I suppose it to have been supported by pillars. From hence, in many of our old plays, part of the dialogue was spoken; and in the front of this balcony curtains likewise were hung.

"A doubt has been entertained whether in our ancient theatres there were side and other scenes. The question is involved in so much obscurity, that it is very difficult to form any decided opinion upon it. It is certain, that in the year 1605 Inigo Jones exhibited an entertainment at Oxford, in which moveable scenes were used; but he appears to have introduced several pieces of machinery in the masques at court, with which undoubtedly the public theatres were unacquainted. A passage which has been produced from one of the old comedies, proves, it must be owned, that even these were furnished with some pieces of machinery, which were used when it was requisite to exhibit the descent of some god or saint; but from all the contemporary accounts, I am inclined to believe that the mechanism of our ancient stage seldom went beyond a painted chair or a trap-door, and that few, if any of them, had any moveable scenes. When king Henry VIII. is to be discovered by the dukes of Suffolk and Norfolk, reading in his study, the scenical direction in the first folio, 1623, (which was printed apparently from play-house copies), is, 'the king draws the curtain, *(i. e.* draws it open), and sits reading pensively;' for, besides the principal curtains that hung in the front of the stage, they used others as substitutes for scenes. If a bed-chamber is to be exhibited, no change of scene is mentioned; but the property-man is simply ordered to thrust forth a bed. When the fable requires the Roman capitol to be exhibited, we find two officers enter, 'to lay cushions, as it were, in the capitol,' &c. On the whole, it appears, that our ancient theatres, in general, were only furnished with curtains, and a single scene composed of tapestry, which were sometimes, perhaps, ornamented with pictures; and some passages in our old dramas incline one to think, that

when tragedies were performed the stage was hung with black.

"In the early part, at least, of our author's acquaintance with the theatre, the want of scenery seems to have been supplied by the simple expedient of writing the names of the different places where the scene was laid in the progress of the play, which were disposed in such a manner as to be visible to the audience. The invention of trap-doors, however, appears not to be modern; for in an old *morality*, intitled *All for Money*, we find a marginal direction which implies that they were very early in use. The covering, or internal roof of the stage, was anciently termed the heavens. It was probably painted of a sky-blue colour, or perhaps pieces of drapery tinged with blue were suspended across the stage to represent the heavens.

"It is probable that the stage was formerly lighted by two large branches, of a form similar to those now hung in churches. They gave place in a subsequent period to small circular wooden frames, furnished with candles, eight of which were hung on the stage, four at either side, and these within a few years were wholly removed by Mr Garrick, who, on his return from France, first introduced the present commodious method of illuminating the stage by lights not visible to the audience. Many of the companies of players were formerly so thin, that one person played two or three parts; and a battle on which the fate of an empire was supposed to depend was decided by half a dozen combatants. It appears to have been a common practice in their mock engagements to discharge small pieces of ordnance on the stage. Before the exhibition began, three flourishes or pieces of music were played, or, in the ancient language, there were three soundings. Music was likewise played between the acts. The instruments chiefly used were trumpets, cornets, and hautboys. The band, which did not consist of more than five or six performers, sat in an upper balcony, over what is now called the stage-box.

"The person who spoke the prologue was ushered in by trumpets, and usually wore a long black velvet cloak, which, I suppose, was considered as best suited to a supplicatory address. Of this custom, whatever might have been its origin, some traces remained till very lately, a black coat having been, if I mistake not, within these few years, the constant stage-habiliment of our modern prologue-speakers. The dress of the ancient prologue-speaker is still retained in the play that is exhibited in Hamlet before the king and court of Denmark. The performers of male characters generally wore periwigs, which in the age of Shakespeare were not in common use. It appears, from a passage in Puttenham's *Art of English Poesy*, 1589, that vizards were on some occasions used by the actors of those days; and it may be inferred, from a scene in one of our author's comedies, that they were sometimes worn in his time by those who performed female characters; but this I imagine was very rare. Some of the female part of the audience likewise appeared in masks. The stage-dresses, it is reasonable to suppose, were much more costly at some theatres than at others; yet the wardrobe of even the king's servants at the Globe and Blackfriars, was, we find, but scantily furnished; and our author's dramas derived very little aid from the splendor of exhibition.

"It is well known, that in the time of Shakespeare, and for many years afterwards, female characters were

Play-house. represented by boys or young men. Sir William D'Avenant, in imitation of the foreign theatres, first introduced females in the scene, and Mrs Betterton is said to have been the first woman that appeared on the English stage. Andrew Pennycuik played the part of Matilda in a tragedy of Davenport's, in 1655; and Mr Kynaston acted several female parts after the Restoration. Downes, a contemporary of his, assures us, 'that being then very young he made a complete stage beauty, performing his parts so well, particularly Arthiope and Aglaura, that it has since been disputable among the judicious whether any woman that succeeded him touched the audience so sensibly as he.'

"Both the prompter, or book-holder, as he was sometimes called, and the property-man, appear to have been regular appendages of our ancient theatres. No writer that I have met with intimates, that in the time of Shakespeare it was customary to exhibit more than a single dramatic piece on one day. The Yorkshire tragedy, or *All's One*, indeed, appears to have been one of four pieces that were represented on the same day; and Fletcher has also a piece called *Four Plays in One*; but probably these were either exhibited on some particular occasion, or were ineffectual efforts to introduce a new species of amusement; for we do not find any other instances of the same kind. Had any shorter pieces been exhibited after the principal performance, some of them probably would have been printed: but there are none extant of an earlier date than the time of the Restoration. The practice, therefore, of exhibiting two dramas successively in the same evening, we may be assured was not established before that period. But though the audiences in the time of our author were not gratified by the representation of more than one drama in the same day, the entertainment was diversified, and the populace diverted, by vaulting, tumbling, slight of hand, and morris-dancing, a mixture not much more heterogeneous than that with which we are daily presented, a tragedy and a farce.

"The amusements of our ancestors, before the commencement of the play, were of various kinds, such as reading, playing at cards, drinking ale, or smoking tobacco. It was a common practice to carry table-books to the theatre, and either from curiosity or enmity to the author, or some other motive, to write down passages of the play that was represented: and there is reason to believe that the imperfect and mutilated copies of some of Shakespeare's dramas, which are yet extant, were taken down in short-hand during the exhibition. At the end of the piece, the actors, in noblemen's houses and in taverns, where plays were frequently performed, prayed for the health and prosperity of their patrons; and in the public theatres for the king and queen. This prayer sometimes made part of the epilogue. Hence, probably, as Mr Steevens has observed, the addition of *Vivant rex et regina* to the modern play-bills.

"Plays, in the time of our author, began at one o'clock in the afternoon; and the exhibition was usually finished in two hours. Even in 1667 they commenced at three. When Goffson wrote his *School of Abuse* in 1579, it seems the dramatic entertainments were usually exhibited on Sundays. Afterwards they were performed on that and other days indiscriminately. It appears from a contemporary writer, that exhibiting plays on Sunday had not been abolished in the third year of king Charles I.

"The modes of conveyance to the theatre, anciently

as at present, seem to have been various; some going in coaches, others on horseback, and many by water.—To the Globe play-house the company probably were conveyed by water; to that in Blackfriars the gentry went either in coaches or on horseback, and the common people on foot. In an epigram to Sir John Davis, the practice of riding to the theatre is ridiculed as a piece of affectation or vanity, and therefore we may presume it was not very general.

"The long and whimsical titles that are prefixed to the quarto copies of our author's plays, I suppose to have been transcribed from the play-bills of the time. A contemporary writer has preserved something like a play-bill of those days, which seems to corroborate this observation; for if it were divested of rhyme, it would bear no very distant resemblance to the title pages that stand before some of our author's dramas:

"———Prithee, what's the play?

"(The first I visited this twelvemonth day)

"They say—"A new invented play of Purle,

"That jeopard'd his neck to steal a girl

"Of twelve; and lying fast impounded for't,

"Has hither sent his bearde to act his part;

"Against all those in open malice bent,

"That would not freely to the theft consent:

"Feigns all to's wish, and in the epilogue

"Goes out applauded for a famous—rogue."

"—Now hang me if I did not look at first

"For some such stuff, by the fond people's thrust."

"It is uncertain at what time the usage of giving authors a benefit on the third day of the exhibition of their pieces commenced. Mr Oldys, in one of his manuscripts, intimates that dramatic poets had anciently their benefit on the first day that a new play was represented; a regulation which would have been very favourable to some of the ephemeral productions of modern times. But for this there is not, I believe, any sufficient authority. From D'Avenant, indeed, we learn, that in the latter part of the reign of queen Elizabeth the poet had his benefit on the second day. As it was a general practice in the time of Shakespeare to sell the copy of the play to the theatre, I imagine in such cases an author derived no other advantage from his piece than what arose from the sale of it. Sometimes, however, he found it more beneficial to retain the copyright in his own hands; and when he did so, I suppose he had a benefit. It is certain that the giving authors the profit of the third exhibition of their play, which seems to have been the usual mode during almost the whole of the last century, was an established custom in the year 1612; for Decker, in the prologue to one of his comedies printed in that year, speaks of the poet's third day. The unfortunate Otway had no more than one benefit on the production of a new play; and this too, it seems, he was sometimes forced to mortgage before the piece was acted. Southerne was the first dramatic writer who obtained the emoluments arising from two representations; and to Farquhar, in the year 1700, the benefit of a third was granted. When an author sold his piece to the sharers or proprietors of a theatre, it remained for several years unpublished; but when that was not the case, he printed it for sale, to which many seem to have been induced, from an apprehension that an imperfect copy might be issued from the press without

Playhouse, but their consent. The customary price of the copy of a play in the time of Shakespeare appears to have been twenty nobles, or six pounds thirteen shillings and four pence. The play when printed was sold for sixpence; and the usual present from a patron in return for a dedication was forty shillings. On the first day of exhibiting a new play, the prices of admission appear to have been raised; and this seems to have been occasionally practised on the benefit-nights of authors to the end of the last century. The custom of passing a final censure on plays at their first exhibition is as ancient as the time of our author; for no less than three plays of his rival Ben Jonson appear to have been damned; and Fletcher's Faithful Shepherdes, and The Knight of the Burning Pestle, written by him and Beaumont, underwent the same fate.

"It is not easy to ascertain what were the emoluments of a successful actor in the time of Shakespeare. They had not then annual benefits as at present. The performers at each theatre seem to have shared the profits arising either from each day's exhibition or from the whole season among them. From Ben Jonson's Poetaster we learn, that one of either the performers or proprietors had seven shares and a half; but of what integral sum is not mentioned. From the prices of admission into our ancient theatres, which have been already mentioned, I imagine the utmost that the sharers of the Globe play-house could have received on any one day was about L. 35. So lately as the year 1685, Shadwell received by his third day on the representation of the Squire of Alsatia, L. 130; which Downes the prompter says was the greatest receipt that had been ever taken at Drury-Lane playhouse at single prices. It appears from the MSS. of Lord Stanhope, treasurer of the chambers to King James I. that the customary sum paid to John Heminge and his company for the performance of a play at court was twenty nobles, or six pounds thirteen shillings and four pence. And Edward Alleyn mentions in his Diary, that he once had so slender an audience in his theatre called the *Fortune*, that the whole receipts of the house amounted to no more than three pounds and some odd shillings.

"Thus scanty and meagre were the apparatus and accommodations of our ancient theatres, on which those dramas were first exhibited, that have since engaged the attention of so many learned men, and delighted so many thousand spectators. Yet even then, we are told by a writer of that age, 'that dramatic poetry was so lively expressed and represented on the public stages and theatres of this city, as Rome in the age of her pomp and glory never saw it better performed; in respect of the action and art, not of the cost and sumptuousness.'

PLEA, in law, is what either party alleges for himself in court, in a cause there depending; and in a more restrained sense, it is the defendant's answer to the plaintiff's declaration.

Pleas are usually divided into those of the crown and common pleas. Pleas of the crown are all suits in the king's name, or in the name of the attorney-general in behalf of the king, for offences committed against his crown and dignity, and against his peace; as treason, murder, felony, &c. See ARRAIGNMENT.

Common pleas are such suits as are carried on between common persons in civil cases. These pleas are

of two sorts; *dilatory* pleas, and pleas *to the action*. Dilatory pleas are such as tend merely to delay or put off the suit, by questioning the propriety of the remedy, rather than by denying the injury: pleas to the action are such as dispute the very cause of suit.

1. *Dilatory* pleas are, 1. To the jurisdiction of the court: alleging, that it ought not to hold plea of this injury, it arising in Wales or beyond sea; or because the land in question is of ancient demesne, and ought only to be demanded in the lord's court, &c. 2. To the disability of the plaintiff, by reason whereof he is incapable to commence or continue the suit; as, that he is an alien enemy, outlawed, excommunicated, attainted of treason or felony, under a præmunire, not *in rerum natura* (being only a fictitious person), an infant, a feme-covert, or a monk professed. 3. In abatement: which abatement is either of the writ, or the count, for some defect in one of them; as by misnaming the defendant, which is called a *misnomer*; giving him a wrong addition, as esquire instead of knight; or other want of form in any material respect. Or, it may be that the plaintiff is dead; for the death of either party is at once an abatement of the suit.

These pleas to the jurisdiction, to the disability, or in abatement, were formerly very often used as mere dilatory pleas, without any foundation in truth, and calculated only for delay; but now by stat. 4 & 5 Ann. c. 16. no dilatory plea is to be admitted without affidavit made of the truth thereof, or some probable matter shown to the court to induce them to believe it true. And with respect to the pleas themselves, it is a rule, that no exception shall be admitted against a declaration or writ, unless the defendant will in the same plea give the plaintiff a better; that is, show him how it might be amended, that there may not be two objections upon the same account.

All pleas to the jurisdiction conclude to the cognizance of the court; praying "judgment whether the court will have farther cognizance of the suit." Pleas to the disability conclude to the person; by praying "judgment, if the said A the plaintiff ought to be answered:" And pleas in abatement (when the suit is by original) conclude to the writ or declaration; by praying "judgment of the writ, or declaration, and that the same may be quashed," *casetur*, made void, or abated: but if the action be by bill, the plea must pray "judgment of the bill," and not of the declaration; the bill being here the original, and the declaration only a copy of the bill.

When these dilatory pleas are allowed, the cause is either dismissed from that jurisdiction, or the plaintiff is stayed till his disability be removed; or he is obliged to sue out a new writ, by leave obtained from the court, or to amend and new-frame his declaration. But when, on the other hand, they are over-ruled as frivolous, the defendant has judgment of *respondeat ouster*, or to answer over in some better manner. It is then incumbent on him to plead.

2. A plea *to the action*; that is, to answer to the merits of the complaint. This is done by confessing or denying it.

A confession of the whole complaint is not very usual; for then the defendant would probably end the matter sooner, or not plead at all, but suffer judgment to go

Plea.

Plea. by default. Yet sometimes, after tender and refusal of a debt, if the creditor harasses his debtor with an action, it then becomes necessary for the defendant to acknowledge the debt, and plead the tender; adding, that he has always been ready, *tout temps prêt*, and is still ready, *uncore prêt*, to discharge it: for a tender by the debtor and refusal by the creditor will in all cases discharge the costs; but not the debt itself; though in some particular cases the creditor will totally lose his money. But frequently the defendant confesses one part of the complaint (by a *cognovit actionem* in respect thereof), and traverses or denies the rest; in order to avoid the expence of carrying that part to a formal trial, which he has no ground to litigate. A species of this sort of confession is the *payment of money into court*: which is for the most part necessary upon pleading a tender, and is itself a kind of tender to the plaintiff; by paying into the hands of the proper officer of the court as much as the defendant acknowledges to be due, together with the costs hitherto incurred, in order to prevent the expence of any farther proceedings. This may be done upon what is called a *motion*: which is an occasional application to the court by the parties or their counsel, in order to obtain some rule or order of court, which becomes necessary in the progress of a cause; and it is usually grounded upon an *affidavit* (the perfect tense of the verb *affido*), being a voluntary oath before some judge or officer of the court, to evince the truth of certain facts, upon which the motion is grounded: though no such affidavit is necessary for payment of money into court. If, after the money is paid in, the plaintiff proceeds in his suit, it is at his own peril: for if he does not prove more due than is so paid into court, he shall be nonsuited and pay the defendant's costs; but he shall still have the money so paid in, for that the defendant has acknowledged to be his due. To this head may also be referred the practice of what is called a *set off*; whereby the defendant acknowledges the justice of the plaintiff's demand on the one hand; but on the other, sets up a demand of his own, to counterbalance that of the plaintiff, either in the whole or in part; as, if the plaintiff sues for ten pounds due on a note of hand, the defendant may set off nine pounds due to himself for merchandize sold to the plaintiff; and, in case he pleads such set-off, must pay the remaining balance into court.

Pleas that totally deny the cause of complaint are either the general issue, or a special plea in bar.

1. The *general issue*, or general plea, is what traverses, thwarts, and denies at once, the whole declaration, without offering any special matter whereby to evade it. As in trespass either *vi et armis*, or on the case, "*non culpabilis*, not guilty;" in debt upon contract, "*nihil debet*, he owes nothing;" in debt on bond, "*non est factum*, it is not his deed;" on an *assumpsit*, "*non assumpsit*, he made no such promise." Or in real actions, "*nul tort*, no wrong done; *nul disseisin*, no disseisin;" and in a writ of right, the mise or issue is, that "the tenant has more right to hold than the demandant has to demand." These pleas are called the *general issue*, because, by importing an absolute and general denial of what is alleged in the declaration, they amount at once to an issue; by which we mean a fact affirmed on one side and denied on the other.

2. *Special* pleas in bar of the plaintiff's demands are very various, according to the circumstances of the de-

fendant's case. As, in real actions, a general release or a fine; both of which may destroy and bar the plaintiff's title. Or, in personal actions, an accord, arbitration, conditions performed, nonage of the defendant, or some other fact which precludes the plaintiff from his action. A *justification* is likewise a special plea in bar; as in actions of assault and battery, *son assault demaine*, that it was the plaintiff's own original assault; in trespass, that the defendant did the thing complained of in right of some office which warranted him so to do; or, in an action of slander, that the plaintiff is really as bad a man as the defendant said he was.

Also a man may plead the statutes of limitation in bar; or the time limited by certain acts of parliament, beyond which no plaintiff can lay his cause of action. This, by the statute of 32 Hen. VIII. c. 2. in a writ of right is 60 years: in assises, writs of entry, or other possessory actions real, of the seisin of one's ancestors in lands; and either of their seisin, or one's own, in rents, suits, and services, 50 years: and in actions real for lands grounded upon one's own seisin or possession, such possession must have been within 30 years. By statute 1 Mar. II. c. 5. this limitation does not extend to any suit for avowsons. But by the statute 21 Jac. I. c. 2. a time of limitation was extended to the case of the king; viz. 60 years precedent to 19th Feb. 1623: but, this becoming ineffectual by efflux of time, the same date of limitation was fixed by statute 9 Geo. III. c. 16. to commence and be reckoned backwards, from the time of bringing any suit or other process to recover the thing in question; so that a possession for 60 years is now a bar even against the prerogative, in derogation of the ancient maxim, *Nullum tempus occurrit regi*. By another statute, 21 Jac. I. c. 16. 20 years is the time of limitation in any writ of formedon: and, by a consequence, 20 years is also the limitation in every action of ejectment; for no ejectment can be brought, unless where the lessor of the plaintiff is intitled to enter on the lands, and by the statute 21 Jac. I. c. 16. no entry can be made by any man, unless within 20 years after his right shall accrue. Also all actions of trespass (*quare clausum fregit*, or otherwise), detinue, trover, replevin, account, and case (except upon accounts between merchants), debt on simple contract, or for arrears of rent, are limited by the statute last mentioned to six years after the cause of action commenced: and actions of assault, menace, battery, mayhem, and imprisonment, must be brought within four years, and actions for words two years, after the injury committed. And by the statute 31 Eliz. c. 5. all suits, indictments, and informations, upon any penal statutes, where any forfeiture is to the crown, shall be sued within two years, and where the forfeiture is to a subject, within one year, after the offence committed, unless where any other time is specially limited by the statute. Lastly, by statute 10 W. III. c. 14. no writ of error, *scire facias*, or other writ, shall be brought to reverse any judgment, fine, or recovery, for error, unless it be prosecuted within 20 years. The use of these statutes of limitation is to preserve the peace of the kingdom, and to prevent those innumerable perjuries which might ensue if a man were allowed to bring an action for any injury committed at any distance of time. Upon both these accounts the law therefore holds, that *interest reipublice ut sit finis litium*: and upon the same principle the Athenian laws in general prohibited

hibited all actions where the injury was committed five years before the complaint was made. If therefore, in any suit, the injury, or cause of action, happened earlier than the period expressly limited by law, the defendant may plead the statutes of limitations in bar: as upon an *assumpsit*, or promise to pay money to the plaintiff, the defendant may plead, *Non assumpsit infra sex annos*, He made no such promise within six years; which is an effectual bar to the complaint.

An *estoppel* is likewise a special plea in bar; which happens where a man hath done some act, or executed some deed, which estops or precludes him from averring any thing to the contrary. As if a tenant for years (who hath no freehold) levies a fine to another person. Tho' this is void as to strangers, yet it shall work as an estoppel to the cognizor; for, if he afterwards brings an action to recover these lands, and his fine is pleaded against him, he shall thereby be estopped from saying, that he had no freehold at the time, and therefore was incapable of levying it.

The conditions and qualities of a plea (which, as well as the doctrine of estoppels, will also hold equally, *mutatis mutandis*, with regard to other parts of pleading), are, 1. That it be single and containing only one matter; for duplicity begets confusion. But by statute 4 and 5 Ann. c. 16. a man, with leave of the court, may plead two or more distinct matters or single pleas; as in an action of assault and battery, these three, Not guilty, *son assault demefne*, and the statute of limitations. 2. That it be direct and positive, and not argumentative. 3. That it have convenient certainty of time, place, and persons. 4. That it answer the plaintiff's allegations in every material point. 5. That it be so pleaded as to be capable of trial.

Special pleas are usually in the affirmative, sometimes in the negative, but they always advance some new fact not mentioned in the declaration; and then they must be averred to be true in the common form:—"And this he is ready to verify."—This is not necessary in pleas of the general issue, those always containing a total denial of the facts before advanced by the other party, and therefore putting him upon the proof of them. See PLEADINGS.

PLEA to Indictment, the defensive matter alleged by a criminal on his indictment: (see ARRAIGNMENT.) This is either, 1. A plea to the jurisdiction; 2. A demurrer; 3. A plea in abatement; 4. A special plea in bar; or, 5. The general issue.

I. A plea to the *jurisdiction*, is where an indictment is taken before a court that hath no cognizance of the offence; as if a man be indicted for a rape at the sheriff's tourn, or for treason at the quarter-sessions: in these or similar cases, he may except to the jurisdiction of the court, without answering at all to the crime alleged.

II. A *demurrer* to the indictment, is incident to criminal cases, as well as civil, when the fact as alleged is allowed to be true, but the prisoner joins issue upon some point of law in the indictment by which he insists, that the fact, as stated, is no felony, treason, or whatever the crime is alleged to be. Thus, for instance, if a man be indicted for feloniously stealing a greyhound; which is an animal in which no valuable property can be had, and therefore it is not felony, but only a civil trespass to steal it; in this case the party indicted may demur to the indictment; denying it to be felony, tho'

he confesses the act of taking it. Some have held, that if, on demurrer, the point of law be adjudged against the prisoner, he shall have judgment and execution, as if convicted by verdict. But this is denied by others, who hold, that in such case he shall be directed and received to plead the general issue, Not guilty, after a demurrer determined against him. Which appears the more reasonable, because it is clear, that if the prisoner freely discovers the fact in court, and refers it to the opinion of the court whether it be felony or no; and upon the fact thus shown, it appears to be felony, the court will not record the confession, but admit him afterwards to plead not guilty. And this seems to be a case of the same nature, being for the most part a mistake in point of law, and in the conduct of his pleading; and, though a man by mispleading may in some cases lose his property, yet the law will not suffer him by such niceties to lose his life. However, upon this doubt, demurrers to indictments are seldom used: since the same advantages may be taken upon a plea of not guilty; or afterwards, in arrest of judgment, when the verdict has established the fact.

III. A plea in *abatement* is principally for a *misnomer*, a wrong name, or a false addition to the prisoner. As, if James Allen, gentleman, is indicted by the name of *John Allen, esquire*, he may plead that he has the name of *James*, and not of *John*; and that he is a *gentleman*, and not an *esquire*. And, if either fact is found by a jury, then the indictment shall be abated, as writs or declarations may be in civil actions. But, in the end, there is little advantage accruing to the prisoner by means of these dilatory pleas; because, if the exception be allowed, a new bill of indictment may be framed, according to what the prisoner in his plea avers to be his true name and addition. For it is a rule, upon all pleas in abatement, that he who takes advantage of a flaw, must at the same time show how it may be amended. Let us therefore next consider a more substantial kind of plea, *viz.*

IV. Special pleas in *bar*; which go to the merits of the indictment, and give a reason why the prisoner ought not to answer it at all, nor put himself upon his trial for the crime alleged. These are of four kinds: a former acquittal, a former conviction, a former attainder, or a pardon. There are many other pleas which may be pleaded in bar of an appeal: but these are applicable to both appeals and indictments.

1. First, the plea of *autrefois acquit*, or a former acquittal, is grounded on this universal maxim of the common law of England, that no man is to be brought into jeopardy of his life, more than once, for the same offence. And hence it is allowed as a consequence, that when a man is once fairly found not guilty upon any indictment, or other prosecution, before any court having competent jurisdiction of the offence, he may plead such acquittal in bar of any subsequent accusation for the same crime.

2. Secondly, the plea of *autrefois convict*, or a former conviction for the same identical crime, though no judgment was ever given, or perhaps will be (being suspended by the benefit of clergy or other causes), is a good plea in bar to an indictment. And this depends upon the same principle as the former, that no man ought to be twice brought in danger of his life for one and the same crime.

Plea.

3. Thirdly, the plea of *autrefois attainé*, or a former attainer, is a good plea in bar, whether it be for the same or any other felony. For wherever a man is attainted of felony, by judgment of death either upon a verdict or confession, by outlawry, or heretofore by abjuration, and whether upon an appeal or an indictment; he may plead such attainer in bar to any subsequent indictment or appeal, for the same or for any other felony. And this because, generally, such proceeding on a second prosecution cannot be to any purpose; for the prisoner is dead in law by the first attainer, his blood is already corrupted, and he hath forfeited all that he had: so that it is absurd and superfluous to endeavour to attain him a second time. Though to this general rule, as to all others, there are some exceptions; wherein, *cessante ratione, cessat et ipsa lex*.

4. Lastly, a pardon may be pleaded in bar; as at once destroying the end and purpose of the indictment, by remitting that punishment, which the prosecution is calculated to inflict. There is one advantage that attends pleading a pardon in bar, or in arrest of judgment, before sentence is past; which gives it by much the preference to pleading it after sentence or attainer. This is, that by stopping the judgment it stops the attainer, and prevents the corruption of the blood: which, when once corrupted by attainer, cannot afterwards be restored otherwise than by act of parliament.

V. The *general issue*, or plea of not guilty, upon which plea alone the prisoner can receive his final judgment of death. In case of an indictment of felony or treason, there can be no special justification put in by way of plea. As, on an indictment for murder, a man cannot plead that it was in his own defence against a robber on the highway, or a burglar; but he must plead the general issue, Not guilty, and give this special matter in evidence. For (besides that these pleas do in effect amount to the general issue; since, if true, the prisoner is most clearly not guilty) as the facts in treason are laid to be done *proditorie et contra ligeantiae suae debitum*; and, in felony, that the killing was done *felonice*; these charges, of a traitorous or felonious intent, are the points and very gist of the indictment, and must be answered directly, by the general negative, Not guilty; and the jury upon the evidence will take notice of any defensive matter, and give their verdict accordingly as effectually as if it were or could be specially pleaded. So that this is, upon all accounts, the most advantageous plea for the prisoner.

When the prisoner hath thus pleaded not guilty, *non culpabilis*, or *nient culpable*: which was formerly used to be abbreviated upon the minutes, thus, *Non* (or *nient*) *cul.* the clerk of the assize, or clerk of arraigns, on behalf of the crown replies, that the prisoner is guilty, and that he is ready to prove him so. This is done by two monosyllables in the same spirit of abbreviation, *cul. prit.*: which signifies first that the prisoner is guilty, (*cul. culpable*, or *culpabilis*); and then that the king is ready to

prove him so, (*prit, presso sum.* or *paratus, verificare*). By this replication the king and the prisoner are therefore at issue: for when the parties come to a fact which is affirmed on one side and denied on the other, then they are said to be at issue in point of fact: which is evidently the case here, in the plea of *non cul.* by the prisoner; and the replication of *cul.* by the clerk.

How the courts came to express a matter of this importance in so odd and obscure a manner, can hardly be pronounced with certainty. It may perhaps, however, be accounted for by supposing, that these were at first short notes, to help the memory of the clerk, and remind him what he was to reply; or else it was the short method of taking down in court, upon the minutes, the replication and averment; *cul. prit.*: which afterwards the ignorance of succeeding clerks adopted for the very words to be by them spoken (A).

But however it may have arisen, the joining of issue seems to be clearly the meaning of this obscure expression; which has puzzled our most ingenious etymologists, and is commonly understood as if the clerk of the arraigns, immediately on plea pleaded, had fixed an opprobrious name on the prisoner, by asking him, "*culprit*, how wilt thou be tried?" for immediately upon issue joined it is inquired of the prisoner, by what trial he will make his innocence appear. This form has at present reference to appeals and approvements only, wherein the appellee has his choice, either to try the accusation by BATTLE or by JURY. But upon indictments, since the abolition of ORDEAL, there can be no other trial but by jury, *per pais*, or by the country: and therefore, if the prisoner refuses to put himself upon the inquest in the usual form, that is, to answer that he will be tried by God and the country, if a commoner; and, if a peer, by God and his peers; the indictment, if in treason, is taken *pro confesso*; and the prisoner, in cases of felony, is judged to stand mute, and, if he perseveres in his obstinacy, shall now be convicted of the felony.

When the prisoner has thus put himself upon his trial, the clerk answers in the humane language of the law, which always hopes that the party's innocence rather than his guilt may appear, "God send thee a good deliverance." And then they proceed, as soon as conveniently may be, to the trial. See the article TRIAL.

PLEADINGS, in law, are the mutual altercations between the plaintiff and defendant, (see SUIT, WRIT, and PROCESS). They form the third part or stage of a fact; and at present are set down and delivered into the proper office in writing, though formerly they were usually put in by their council *ore tenus*, or *viva voce*, in court, and then minuted down by the chief clerks or prothonotaries; whence, in our old law-French, the pleadings are frequently denominated the *parol*.

The first of these is the *declaration*, *narratio*, or *count*, anciently called the *tale*; in which the plaintiff sets forth his cause of complaint at length: being indeed only an amplification

(A) Of this ignorance we may see daily instances, in the abuse of two legal terms of ancient French: one, the prologue to all proclamations, "*Oyez*, or *Hear ye*," which is generally pronounced, most unmeaningly, "*O yes*:" the other, a more pardonable mistake, viz. when a jury are all sworn, the officer bids the crier number them, for which the word in law French is, "*Countez*;" but we now hear it pronounced in very good English, "*Count these*."

leadings

acknowledgment.

amplification or exposition of the original writ upon which his action is founded, with the additional circumstances of time and place, when and where, the injury was committed.

In *local* actions, where possession of land is to be recovered, or damages for an actual trespass, or for waste, &c. affecting land, the plaintiff must lay his declaration, or declare his injury to have happened in the very county and place that it really did happen; but in *transitory* actions, for injuries that might have happened anywhere, as debt, detinue, slander, and the like, the plaintiff may declare in what county he pleases, and then the trial must be in that county in which the declaration is laid. Though, if the defendant will make affidavit that the cause of action, if any, arose not in that but another county, the court will direct a change of the *venue* or *visne* (that is, the *vicinia* or neighbourhood in which the injury is declared to be done), and will oblige the plaintiff to declare in the proper county. For the statute 6 Ric. II. c. 2. having ordered all writs to be laid in their proper counties, this, as the judges conceived, impowered them to change the *venue*, if required, and not to insist rigidly on abating the writ: which practice began in the reign of James I. And this power is discretionally exercised, so as not to cause but prevent a defect of justice. Therefore the court will not change the *venue* to any of the four northern counties previous to the spring circuit; because there the assizes are holden only once a-year, at the time of summer circuit. And it will sometimes remove the *venue* from the proper jurisdiction (especially of the narrow and limited kind), upon a suggestion, duly supported, that a fair and impartial trial cannot be had therein.

It is generally usual, in actions upon the case, to set forth several cases, by different counts in the same declaration; so that if the plaintiff fails in the proof of one, he may succeed in another. As in an action on the case upon an *ASSUMPSIT* for goods sold and delivered, the plaintiff usually counts or declares, first, upon a settled and agreed price between him and the defendant; as, that they bargained for 20*l.*: and lest he should fail in the proof of this, he counts likewise upon a *quantum valebant*; that the defendant bought other goods, and agreed to pay him so much as they were reasonably worth: and then avers that they were worth other 20*l.* and so on in three or four different shapes; and at last concludes with declaring, that the defendant had refused to fulfil any of these agreements, whereby he is endamaged to such a value. And if he proves the case laid in any one of his counts, though he fails in the rest, he shall recover proportionable damages. This declaration always concludes with these words, "and thereupon he brings suit," &c. *inde productit seiam*, &c. By which words, *suit* or *seia* (*a sequendo*), were anciently understood the witnesses or followers of the plaintiff. For in former times, the law would not put the defendant to the trouble of answering the charge till the plaintiff had made out at least a probable case. But the actual production of the *suit*, *seia*, or *followers*, is now antiquated, and hath been totally disused, at least ever since the reign of Edward III. though the form of it still continues.

At the end of the declaration are added also the

plaintiff's common pledges of prosecution, John Doe and Richard Roe; which, as we elsewhere observe, (see *Writ*), are now mere names of form; though formerly they were of use to answer to the king for the amercement of the plaintiff, in case he were nonsuited, barred of his action, or had a verdict and judgment against him. For if the plaintiff neglects to deliver a declaration for two terms after the defendant appears, or is guilty of other delays or defaults against the rules of law in any subsequent stage of the action, he is adjudged not to follow or pursue his remedy as he ought to do; and thereupon a *non-suit*, or *non-prosequitur*, is entered, and he is said to be *non-prof'd.* And for thus deserting his complaint, after making a false claim or complaint (*pro falso clamore suo*), he shall not only pay costs to the defendant, but is liable to be amerced to the king. A *retraxit* differs from a nonsuit, in that the one is negative and the other positive: the nonsuit is a default and neglect of the plaintiff, and therefore he is allowed to begin his suit again upon payment of costs; but a *retraxit* is an open and voluntary renunciation of his suit in court; and by this he for ever loses his action. A *discontinuance* is somewhat similar to a nonsuit; for when a plaintiff leaves a chasm in the proceedings of his cause, as by not continuing the process regularly from day to day, and time to time, as he ought to do, the suit is discontinued, and the defendant is no longer bound to attend; but the plaintiff must begin again, by suing out a new original, usually paying costs to his antagonist.

When the plaintiff hath stated his case in the declaration, it is incumbent on the defendant, within a reasonable time, to make his defence, and to put in a plea; or else the plaintiff will at once recover judgment by *default*, or *nihil dicit*, of the defendant.

Defence, in its true legal sense, signifies not a justification, protection, or guard, which is now its popular signification; but merely an *opposing* or *denial* (from the French verb *defendre*) of the truth or validity of the complaint. It is the *contestatio litis* of the civilians: a general assertion that the plaintiff hath no ground of action; which assertion is afterwards extended and maintained in his plea.

Before defence made, if at all, cognizance of the suit must be claimed or demanded; when any person or body-corporate hath the franchise, not only of holding pleas within a particular limited jurisdiction, but also of the cognizance of pleas; and that either without any words exclusive of other courts, which intitles the lord of the franchise, whenever any suit that belongs to his jurisdiction is commenced in the courts at Westminster, to demand the cognizance thereof; or with such exclusive words, which also intitle the defendant to plead to the jurisdiction of the court. Upon this claim of cognizance, if allowed, all proceedings shall cease in the superior court, and the plaintiff is left at liberty to pursue his remedy in the special jurisdiction. As, when a scholar or other privileged person of the universities of Oxford or Cambridge is impleaded in the courts at Westminster, for any cause of action whatsoever, unless upon a question of freehold. In these cases, by the charter of those learned bodies, confirmed by act of parliament, the chancellor, or vice-chancellor, may put in a claim of cognizance; which, if made in due time and form, and with due proof of the facts alleged, is regularly

Pleadings. larly allowed by the courts. It must be demanded before full defence is made or imparlance prayed; for these are a submission to the jurisdiction of the superior court, and the delay is a *laches* in the lord of the franchise: and it will not be allowed if it occasions a failure of justice, or if an action be brought against the person himself who claims the franchise, unless he hath also a power in such case of making another judge.

After defence made, the defendant must put in his plea. But before he defends, if the suit is commenced by *capias* or *latitat*, without any special original, he is intitled to demand one *imparlance*, or *licentia loquendi*; and may, before he pleads, have more granted by consent of the court, to see if he can end the matter amicably without farther suit, by talking with the plaintiff: a practice which is supposed to have arisen from a principle of religion, in obedience to that precept of the gospel, "agree with thine adversary quickly, whilst thou art in the way with him." And it may be observed, that this gospel-precept has a plain reference to the Roman law of the twelve tables, which expressly directed the plaintiff and defendant to make up the matter while they were in the way, or going to the prætor;—*in via, rem uti pacent orato*. There are also many other previous steps which may be taken by a defendant before he puts in his plea. He may, in real actions, demand a view of the thing in question, in order to ascertain its identity and other circumstances. He may crave *oyer* of the writ, or of the bond, or other specialty upon which the action is brought; that is, to hear it read to him; the generality of defendants in the times of ancient simplicity being supposed incapable to read it themselves: whereupon the whole is entered *verbatim* upon the record; and the defendant may take advantage of any condition, or other part of it, not stated in the plaintiff's declaration. In real actions also the tenant may pray in *aid*, or call for the assistance of another, to help him to plead, because of the feebleness or imbecility of his own estate. Thus a tenant for life may pray in aid of him that hath the inheritance in remainder or reversion; and an incumbent may pray in aid of the patron and ordinary; that is, that they shall be joined in the action, and help to defend the title. *Voucher* also is the calling in of some person to answer the action, that hath warranted the title to the tenant or defendant. This we still make use of in the form of common recoveries, which are grounded on a writ of entry; a species of action that relies chiefly on the weakness of the tenant's title, who therefore vouches another person to warrant it. If the vouchee appears, he is made defendant instead of the voucher; but if he afterwards makes default, recovery shall be had against the original defendant; and he shall recover an equivalent in value against the deficient vouchee. In assizes, indeed, where the principal question is, whether the demandant or his ancestors were or were not in possession till the ouster happened, and the title of the tenant is little (if at all) discussed, there no voucher is allowed; but the tenant may bring a writ of *warrantia chartæ* against the warrantor, to compel him to assist him with a good plea or defence, or else to render damages and the value of the land, if recovered against the tenant. In many real actions also, brought by or against an infant under the age of 21 years, and also in actions of debt brought against him, as heir to any deceased

Pleadings. ancestor, either party may suggest the nonage of the infant, and pray that the proceedings may be deferred till his full age, or, in our legal phrase, that the infant may have his age, and that the *parol may demur*, that is, that the pleadings may be staid; and then they shall not proceed till his full age, unless it be apparent that he cannot be prejudiced thereby. But by the statutes of Westm. 1. 3 Edw. I. c. 46. and of Gloucester, 6 Edw. I. c. 2. in writs of entry *sur disseisin* in some particular cases, and in actions auncestrel brought by an infant, the parol shall not demur; otherwise he might be deforced of his whole property, and even want a maintenance, till he came of age. So likewise in a writ of dower the heir shall not have his age; for it is necessary that the widow's claim be immediately determined, else she may want a present subsistence. Nor shall an infant patron have it in a *quare impedit*, since the law holds it necessary and expedient that the church be immediately filled.

When these proceedings are over, the defendant must then put in his excuse or plea. See **PLEA**.

It is a rule in pleading, that no man be allowed to plead specially such a plea as amounts only to the general issue, or a total denial of the charge; but in such case he shall be driven to plead the general issue in terms, whereby the whole question is referred to a jury. But if the defendant, in an assize or action of trespass, be desirous to refer the validity of his title to the court rather than the jury, he may state his title specially; and at the same time give colour to the plaintiff, or suppose him to have an appearance or colour of title, bad indeed in point of law, but of which the jury are not competent judges. As if his own true title is, that he claims by feoffment with livery from A, by force of which he entered on the lands in question, he cannot plead this by itself, as it amounts to no more than the general issue, *nul tort, nul disseisin*, in assize, or *not guilty* in an action of trespass. But he may allege this specially, provided he goes farther, and says, that the plaintiff claiming by colour of a prior deed of feoffment, without livery, entered; upon whom he entered; and may then refer himself to the judgment of the court which of these two titles is the best in point of law.

When the plea of the defendant is thus put in, if it does not amount to an issue or total contradiction of the declaration, but only evades it, the plaintiff may plead again, and reply to the defendant's plea: Either traversing it, that is, totally denying it; as if, on an action of debt upon bond, the defendant pleads *solvit ad diem*, that he paid the money when due; here the plaintiff in his replication may totally traverse this plea, by denying that the defendant paid it: Or he may allege new matter in contradiction to the defendant's plea; as when the defendant pleads no award made, the plaintiff may reply, and set forth an actual award, and assign a breach: Or the replication may confess and avoid the plea, by some new matter or distinction, consistent with the plaintiff's former declaration; as in an action for trespassing upon land whereof the plaintiff is seized, if the defendant shows a title to the land by descent, and that therefore he had a right to enter, and gives colour to the plaintiff, the plaintiff may either traverse and totally deny the fact of the descent; or he may confess and avoid it, by replying, that true it is that such descent

leadings. scent happened, but that since the descent the defendant himself demised the lands to the plaintiff for term of life. To the replication the defendant may *rejoin*, or put in an answer called a *rejoinder*. The plaintiff may answer the rejoinder by a *sur rejoinder*; upon which the defendant may *rebut*, and the plaintiff answer him by a *sur-rebutter*. Which pleas, replications, rejoinders, sur-rejoinders, rebutters, and sur-rebutters, answer to the *exceptio, replicatio, duplicatio, triplicatio, and quadruplicatio*, of the Roman laws.

The whole of this process is denominated the *pleading*; in the several stages of which it must be carefully observed, not to depart or vary from the title or defence which the party has once insisted on. For this (which is called a *departure* in pleading) might occasion endless altercation. Therefore the replication must support the declaration, and the rejoinder must support the plea, without departing out of it. As in the case of pleading no award made in consequence of a bond of arbitration, to which the plaintiff replies, setting forth an actual award; now the defendant cannot rejoin that he hath performed this award, for such rejoinder would be an entire departure from his original plea, which alleged that no such award was made: therefore he has now no other choice, but to traverse the fact of the replication, or else to demur upon the law of it.

Again, all duplicity in pleading must be avoided. Every plea must be simple, entire, connected, and confined to one single point: it must never be entangled with a variety of distinct independent answers to the same matter; which must require as many different replies, and introduce a multitude of issues upon one and the same dispute. For this would often embarrass the jury, and sometimes the court itself, and at all events would greatly enhance the expence of the parties. Yet it frequently is expedient to plead in such a manner as to avoid any implied admission of a fact, which cannot with propriety or safety be positively affirmed or denied. And this may be done by what is called a *protestation*; whereby the party interposes an oblique allegation or denial of some fact, protesting (by the gerund, *protestando*) that such a matter does or does not exist; and at the same time avoiding a direct affirmation or denial. Sir Edward Coke hath defined a protestation (in the pithy dialect of that age) to be, "an exclusion of a conclusion." For the use of it is, to save the party from being concluded with respect to some fact or circumstance which cannot be directly affirmed or denied without falling into duplicity of pleading; and which yet, if he did not thus enter his protest, he might be deemed to have tacitly waved or admitted. Thus, while tenure in villainage subsisted, if a villain had brought an action against his lord, and the lord was inclined to try the merits of the demand, and at the same time to prevent any conclusion against himself that he had waved his signiory; he could not in this case both plead affirmatively that the plaintiff was his villain, and also take issue upon the demand; for then his plea would have been double, as the former alone would have been a good bar to the action: but he might have alleged the villainage of the plaintiff by way of protestation, and then have denied the demand. By this means the future vassalage of the plaintiff was saved to the defendant, in case the issue was found in his (the defendant's) favour; for the protestation prevented that conclusion which would

otherwise have resulted from the rest of his defence, that he had enfranchised the plaintiff, since no villain could maintain a civil action against his lord. So also if a defendant, by way of inducement to the point of his defence, alleges (among other matters) a particular mode of seisin or tenure which the plaintiff is unwilling to admit, and yet desires to take issue on the principal point of the defence, he must deny the seisin or tenure by way of protestation, and then traverse the defensive matter. So, lastly, if an award be set forth by the plaintiff, and he can assign a breach in one part of it (viz. the non-payment of a sum of money), and yet is afraid to admit the performance of the rest of the award, or to aver in general a non-performance of any part of it, lest something should appear to have been performed; he may save to himself any advantage he might hereafter make of the general non-performance, by alleging that by protestation, he can plead only the non-payment of the money.

In any stage of the pleadings, when either side advances or affirms any new matter, he usually (as was said) avers it to be true; "and this he is ready to verify." On the other hand, when either side traverses or denies the facts pleaded by his antagonist, he usually tenders an *issue*, as it is called; the language of which is different according to the party by whom it is tendered: for if the traverse or denial comes from the defendant, the issue is tendered in this manner, "And of this he puts himself upon the country," thereby submitting himself to the judgment of his peers: but if the traverse lies upon the plaintiff, he tenders the issue or prays the judgment of the peers against the defendant in another form; thus, "and this he prays may be required of by the country."

But if either side (as, for instance, the defendant) pleads a special negative plea, not traversing or denying any thing that was before alleged, but disclosing some new negative matter; as where the suit is on a bond conditioned to perform an award, and the defendant pleads, negatively, that no award was made; he tenders no issue upon this plea, because it does not yet appear whether the fact will be disputed, the plaintiff not having yet asserted the existence of any award: but when the plaintiff replies, and sets forth an actual specific award, if then the defendant traverses the replication, and denies the making of any such award, he then, and not before, tenders an issue to the plaintiff. For when in the course of pleading they come to a point which is affirmed on one side and denied on the other, they are then said to be at issue; all their debates being at last contracted into a single point, which must now be determined either in favour of the plaintiff or of the defendant. See *ISSUE*.

PLEASING, art of. See *POLITENESS*.

PLEASURE is a word so universally understood as to need no explanation. Lexicographers, however, who must attempt to explain every word, call it "the gratification of the mind or senses." It is directly opposite to *PAIN*, and constitutes the whole of positive happiness as that does of misery.

The Author of Nature has furnished us with many pleasures, as well as made us liable to many pains; and we are susceptible of both in some degree as soon as we have life and are endowed with the faculty of sensation. A French writer, in a work* which once raised high expectations

Pleadings
||
Pleasure.

* Encyclo-
pédie Mé-
thodique,
Logique, Mé-
ta-physique,
et Morale, tom. 4.

Pleasure. expectations, contends, that a child in the womb of its mother feels neither pleasure nor pain. "These sensations (says he) are not innate; they have their origin from without: and it is at the moment of our birth that the soul receives the first impressions; impressions slight and superficial at the beginning, but which by time and repeated acts leave deeper traces in the sensorium, and become more extensive and more lasting. It is when the child sends forth its first cries that sensibility or the faculty of sensation is produced, which in a short time gathers strength and stability by the impression of exterior objects. Pleasure and pain not being innate, and being only acquired in the same manner as the qualities which we derive from instruction, education, and society, it follows that we learn to suffer and enjoy as we learn any other science."

This is strange reasoning and strange language. That sensations are not innate is universally acknowledged; but it does not therefore follow that the soul receives its first impressions and first sensations at the moment of birth. The child has life, the power of locomotion, and the sense of touch, long before it is born; and every mother will tell this philosopher, that an infant unborn exhibits symptoms both of pain and of pleasure. That many of our organs of sense are improved by use is incontrovertible; but it is so far from being true that our sensible pleasures become more exquisite by being often repeated, that the direct contrary is experienced of far the greater part of them; and though external objects, by making repeated impressions on the senses, certainly leave deeper traces on the memory than an object once perceived can do, it by no means follows that these impressions become the more delightful the more familiar that they are to us. That we learn to suffer and enjoy as we learn any other science, is a most extravagant paradox; for it is self-evident that we cannot live without being capable in some degree both of suffering and enjoyment, though a man may certainly live to old age in profound ignorance of all the sciences.

The same writer assures us, indeed, that sensation is not necessary to human life. "Philosophers (says he) make mention of a man who had lost every kind of feeling in every member of his body: he was pinched; or pricked to no purpose. Meanwhile this man made use of all his members; he walked without pain, he drank, ate, and slept, without perceiving that he did so. Sensible neither to pleasure nor pain, he was a true natural machine."

To the tale of these anonymous philosophers our author gives implicit credit, whilst he favours us at the same instant with the following argumentation, which completely proves its falsehood. "It is true that sensation is a relative quality, susceptible of increase and diminution; that it is not necessary to existence; and that one might live without it: but in this case he would live as an automaton, without feeling pleasure or pain; and he would possess neither idea, nor reflection, nor desire, nor passion, nor will, nor sentiment; his existence would be merely passive, he would live without knowing it, and die without apprehension."

But if this man of the philosophers, whom our author calls an *automaton*, and a *true natural machine*, had neither *idea*, nor *desire*, nor *passion*, nor *will*, nor *sentiment*

(and without sensation he certainly could have none of them), what induced him to *walk*, *eat*, or *drink*, or to *cease* from any of these operations after they were accidentally begun? The instances of the *automata* which played on the flute and at chess are not to the purpose for which they are adduced; for there is no parallel between them and this natural machine, unless the philosophers wound up their man to eat, drink, walk, or sit, as Vacanson and Kempeler wound up their automata to play or cease from playing on the German flute and at chess. See **ANDROIDES**.

Our author having for a while sported with these harmless paradoxes, proceeds to put the credulity of his reader to the test with others of a very contrary tendency. He institutes an inquiry concerning the superiority, in number and degree, of the pleasures enjoyed by the different orders of men in society; and labours, not indeed by argument, but by loose declamation, to propagate the belief that happiness is very unequally distributed. The pleasures of the rich, he says, must be more numerous and exquisite than those of the poor; the nobleman must have more enjoyments than the plebeian of equal wealth; and the king, according to him, must be the happiest of all men. He owns, indeed, that although "birth, rank, honours, and dignity, add to happiness, a man is not to be considered as miserable because he is born in the lower conditions of life. A man may be happy as a mechanic, a merchant, or a labourer, provided he enters into the spirit of his profession, and has not imbibed by a misplaced education those sentiments which make his condition insupportable. Happiness is of easy acquisition in the middling stations of life; and though perhaps we are unable to know or to rate exactly the pleasure which arises from contentment and mediocrity, yet happiness being a kind of aggregate of delights, of riches, and of advantages more or less great, every person must have a share of it; the division is not exactly made, but all other things equal, there will be more in the elevated than in the inferior conditions of society; the enjoyment will be more felt, the means of enjoying more multiplied, and the pleasures more varied. Birth, rank, fortune, talents, wit, genius, and virtue, are then the great sources of happiness: those advantages are so considerable, that we see men contented with any one of them, but their union forms supreme felicity."

"There is so vast a difference, says Voltaire, between a man who has made his fortune and one who has to make it, that they are scarcely to be considered as creatures of the same kind. The same thing may be said of birth, the greatest of all advantages in a large society; of rank, of honours, and of great abilities. How great a difference is made between a person of high birth and a tradesman; between a Newton or Descartes and a simple mathematician? Ten thousand soldiers are killed on the field of battle, and it is scarcely mentioned; but if the general falls, and especially if he be a man of courage and abilities, the court and city are filled with the news of his death, and the mourning is universal."

"Frederic the Great, the late king of Prussia, felt in a more lively manner than perhaps any other man the value of great talents. I would willingly renounce, said he to Voltaire, every thing which is an object of desire and ambition to man; but I am certain if I were

measure. not a prince I should be nothing. Your merit alone would gain you the esteem, and envy, and admiration of the world; but to secure respect for me, titles, and armies, and revenues, are absolutely necessary."

For what purpose this account of human happiness was published, it becomes not us to say. Its obvious tendency is to make the lower orders of society discontented with their state, and envious of their superiors; and it is not unreasonable to suppose, that it contributed in some degree to excite the ignorant part of the author's countrymen to the commission of those atrocities of which they have since been guilty. That such was his intention, the following extract will not permit us to believe; for though in it the author attempts to support the same false theory of human happiness, he mentions virtuous kings with the respect becoming a loyal subject of the unfortunate Louis, whose character he seems to have intentionally drawn, and whose death by the authority of a savage faction he has in effect foretold.

"Happiness, in a state of society, takes the most variable forms: it is a Proteus susceptible of every kind of metamorphosis: it is different in different men, in different ages, and in different conditions, &c. The pleasures of youth are very different from those of old age: what affords enjoyment to a mechanic would be supreme misery to a nobleman; and the amusements of the country would appear insipid in the capital. Is there then nothing fixed with regard to happiness? Is it of all things the most variable and the most arbitrary? Or, in judging of it, is it impossible to find a standard by which we can determine the limits of the greatest good to which man can arrive in the present state? It is evident that men form the same ideas of the beautiful and sublime in nature, and of right and wrong in morality, provided they have arrived at that degree of improvement and civilization of which human nature is susceptible; and that different opinions on these subjects depend on different degrees of culture, of education, and of improvement. The same thing may be advanced with regard to happiness: all men, if equal with respect to their organs, would form the very same ideas on this subject if they reached the degree of improvement of which we are presently speaking; and in fact, do we not see in the great circles at Rome, at Vienna, at London, and Paris, that those who are called people of fashion, who have received the same education, have nearly the same taste, the same desires, and the same spirit for enjoyment? there is doubtless a certain degree of happiness to be enjoyed in every condition of life; but as there are some conditions preferable to others, so are there degrees of happiness greater and less; and if we were to form an idea of the greatest possible in the present state, it perhaps would be that of a sovereign, master of a great empire, enjoying good health and a moderate spirit; endowed with piety and virtue, whose whole life was employed in acts of justice and mercy, and who governed by fixed and immoveable laws. Such a king is the image of the divinity on earth, and he must be the idol of a wise people. His whole life should present a picture of the most august felicity. Although such sovereigns are rare, yet we are not without examples of them. Ancient history affords us Titus and Marcus Aurelius, and the present age can boast of piety

VOL. XV. Part I.

and munificence in the character of some of its kings. This state of the greatest happiness to which man can reach not being ideal, it will serve as a standard of comparison by which happiness and misery can be estimated in all civilized countries. *He is as happy as a king*, is a proverbial expression, because we believe with justice that royalty is the extreme limit of the greatest enjoyments; and in fact, happiness being the work of man, that condition which comprehends all the degrees of power and of glory, which is the source of honour and of dignity, and which supposes in the person invested with it all means of enjoyment either for himself or others, leaves nothing on this earth to which any reasonable man would give the preference.

"We can find also in this high rank the extreme of the greatest evils to which the condition of nature is exposed. A king condemned to death, and perishing on a scaffold, by the authority of a faction, while at the same time he had endeavoured by every means in his power to promote the general happiness of his subjects, is the most terrible and striking example of human misery; for if it be true that a crown is the greatest of all blessings, then the loss of it, and at the same time the loss of life by an ignominious and unjust sentence, are of all calamities the most dreadful.

"It is also in the courts of kings that we find the most amiable and perfect characters; and it is there where true grandeur, true politeness, the best tone of manners, the most amiable graces, and the most eminent virtues, are completely established. It is in courts that men seem to have acquired their greatest improvement: Whoever has seen a court, says La Bruyere, has seen the world in the most beautiful, the most enchanting, and attractive colours. The prejudices of mankind in behalf of the great are so excessive, that if they inclined to be good they would be almost the objects of adoration."

In this passage there are doubtless many just observations; but there is at least an equal number of others both false and dangerous. That a crown is the greatest of earthly blessings, and that it is in the courts of kings that we meet with the most amiable and perfect characters, are positions which a true philosopher will not admit but with great limitations. The falsehood of the author's general theory respecting the unequal distribution of happiness in society, we need not waste time in exposing. It is sufficiently exposed in other articles of this work, and in one of them by a writer of a very superior order (See HAPPINESS; and MORAL PHILOSOPHY, Part II. chap. ii.) He enters upon other speculations respecting the pleasures and pains of savages, which are ingenious and worthy of attention; but before we proceed to notice them, it will be proper to consider the connection which subsists between pleasure and pain.

"That the cessation of pain is accompanied by pleasure, is a fact (says a philosopher of the first rank) which has been repeatedly observed, but perhaps not sufficiently accounted for. Let us suppose a person in a state of indifference as to heat. Upon coming near a fire, he will experience at first an agreeable warmth, *i. e.* pleasure. If the heat be increased, this state of pleasure will, after a time, be converted into one of pain, from the increased action upon the nerves and brain,

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brain,

Pleasure,

† Dr Sayers.

Pleasure. brain, the undoubted organs of all bodily sensations. Let the heat now be gradually withdrawn, the nervous system must acquire again, during this removal, the state of agreeable warmth or pleasure; and after passing through that state it will arrive at indifference. From this fact then we may conclude, that a state of pleasure may be pushed on till it is converted into one of pain; and, on the other hand, that an action which produces pain will, if it go off gradually, induce at a certain period of its decrease a state of pleasure. The same reasoning which has thus been applied to the body may be extended also to the mind. Total languor of mind is not so pleasant as a certain degree of action or emotion; and emotions pleasant at one period may be increased till they become painful at another; whilst painful emotions, as they gradually expire, will, at a certain period of their decrease, induce a state of pleasure. Hence then we are able to explain why pleasure should arise in all cases from the gradual cessation of any action or emotion which produces pain."

The same author maintains, that from the mere removal of pain, whether by degrees or instantaneously, we always experience pleasure; and if the pain removed was exquisite, what he maintains is certainly true. To account for this phenomenon he lays down the following law of nature, which experience abundantly confirms, *viz.* "that the temporary withdrawing of any action from the body or mind invariably renders them more susceptible of that action when again produced." Thus, after long fasting, the body is more susceptible of the effects of food than if the stomach had been lately satisfied; the action of strong liquors is found to be greater on those who use them seldom than on such as are in the habit of drinking them. Thus, too, with respect to the mind; if a person be deprived for a time of his friend's society, or of a favourite amusement, the next visit of his friend, or the next renewal of his amusement, is attended with much more pleasure than if they had never been withheld from him.

"To apply this law to the case of a person suddenly relieved from acute pain. While he labours with such pain, his mind is so totally occupied by it, that he is unable to attend to his customary pursuits or amusements. He becomes therefore so much more susceptible of their action, that when they are again presented to him, he is raised above his usual indifference to positive pleasure. But all pains do not proceed from an excess of action. Many of them arise from reducing the body or the mind to a state below indifference. Thus, if a person have just sufficient warmth in his body to keep him barely at ease or in a state of indifference, by withdrawing this heat a state of uneasiness or pain is produced; and if in a calm state of mind one be made acquainted with a melancholy event, his quiet is interrupted, and he sinks below indifference into a painful state of mind. If now, without communicating any new source of positive pleasure, we remove in the former case the cold, and in the latter the grief, the persons from whom they are removed will experience real pleasure. Thus, then, whether pain arises from excess or deficiency of action, the gradual or the sudden removal of it must be in all cases attended with pleasure†." It is equally true that the gradual or sudden removal of pleasure is attended with pain.

We are now prepared to examine our French author's

account of the pleasures and pains of savages. "Every age (says he) has its different pleasures; but if we were to imagine that those of childhood are equal to those of confirmed age, we should be much mistaken in our estimation of happiness. The pleasures of philosophy, either natural or moral, are not unfolded to the infant; the most perfect music is a vain noise; the most exquisite perfumes and dishes highly seasoned offend his young organs instead of affording delight; his touch is imperfect; forty days elapse before the child gives any sign of laughter or of weeping; his cries and groans before that period are not accompanied with tears; his countenance expresses no passion; the parts of his face bear no relation to the sentiments of the soul, and are moreover without consistency. Children are but little affected with cold; whether it be that they feel less, or that the interior heat is greater than in adults. In them all the impressions of pleasure and pain are transitory; their memory has scarcely begun to unfold its powers; they enjoy nothing but the present moment; they weep, laugh, and give tones of satisfaction without consciousness, or at least without reflection; their joy is confined to the indulgence of their little whims, and constraint is the greatest of their misfortunes; few things amuse, and nothing satisfies them. In this happy condition of early infancy nature is at the whole expence of happiness; and the only point is not to contradict her. What desires have children? Give them liberty in all their movements, and they have a plenitude of existence, an abundance of that kind of happiness which is confined in some sort to all the objects which surround them: but if all beings were happy on the same conditions, society would be at no expence in procuring the happiness of the different individuals who compose it. Sensation is the foundation of reflection; it is the principal attribute of the soul; it is by this that man is elevated to sublime speculations, and secures his dominion over nature and himself. This quality is not stationary, but susceptible, like all other relative qualities, of increase and decay, of different degrees of strength and intenseness: it is different in different men; and in the same man it increases from infancy to youth, from youth to confirmed manhood: at this period it stops, and gradually declines as we proceed to old age and to second childishness. Considered physically, it varies according to age, constitution, climate, and food; considered in a moral point of view, it takes its different appearances from individual education, and from the habits of society; for man in a state of nature and society, with regard to sensation and the unfolding of his powers, may be considered as two distinct beings: and if one were to make a calculation of pleasure in the course of human life, a man of fortune and capacity enjoys more than ten thousand savages.

"Pleasure and pain being relative qualities, they may be almost annihilated in the moment of vehement passion. In the heat of battle, for example, ardent and animated spirits have not felt the pain of their wounds; and minds strongly penetrated with sentiments of religion, enthusiasm, and humanity, have supported the most cruel torments with courage and fortitude. The sensibility of some persons is so exquisitely alive, that one can scarcely approach them without throwing them into convulsions. Many diseases show the effect of sensibility pushed to an extreme; such as hysteric affections, certain

† *Disquisitions Aetaphysical and Literary.*

Pasure. certain kinds of madness, and some of those which proceed from poison, and from the bite or sting of certain animals, as the viper and the tarantula. Excessive joy or grief, fear and terror, have been known to destroy all sensation, and occasion death (A)''

Having made these preliminary observations on pleasure and pain in infancy, and as they are increased or diminished by education, and the different conditions of body and mind, our author proceeds to consider the capability of savages to feel pleasure and pain. "By savages he understands all the tribes of men who live by hunting and fishing, and on those things which the earth yields without cultivation. Those tribes who possess herds of cattle, and who derive their subsistence from such possessions, are not to be considered as savages, as they have some idea of property. Some savages are naturally compassionate and humane, others are cruel and sanguinary. Although the physical constitution of man be everywhere the same, yet the varieties of climate, the abundance or scarcity of natural productions, have a powerful influence to determine the inclinations. Even the fierceness of the tyger is softened under a mild sky; now nature forms the manners of savages just as society and civil institutions form the manners of civilized life. In the one case climate and food produce almost the whole effect; in the other they have scarcely any influence. The habits of society every moment contend with nature, and they are almost always victorious. The savage devotes himself to the dominion of his passions; the civilized man is employed in restraining, in directing, and in modifying them: so much influence have government, laws, society, and the fear of censure and punishment, over his soul.

"It is not to be doubted that savages are susceptible both of pleasure and pain; but are the impressions made on their organs as sensible, or do they feel pain in the same degree with the inhabitants of a civilized country?

"Their enjoyments are so limited, that if we confine ourselves to truth, a few lines will be sufficient to describe them: our attention must therefore be confined to pain, because the manner in which they support misfortune, and even torture, presents us with a view of character unequalled in the history of civilized nations. It is not uncommon in civilized countries to see men braving death, meeting it with cheerfulness, and even not uttering complaints under the torture; but they do not insult the executioners of public vengeance, and defy pain in order to augment their torments; and those who are condemned by the laws suffer the punishment with different degrees of fortitude. On those mournful occasions, the common ranks of mankind in general die with less firmness: those, on the other hand, who have

received education, and who, by a train of unfortunate events, are brought to the scaffold, whether it be the fear of being reproached with cowardice, or the consideration that the stroke is inevitable, such men discover the expiring sighs of self-love even in their last moments; and those especially of high rank, from their manners and sentiments, are expected to meet death with magnanimity: but an American savage in the moment of punishment appears to be more than human; he is a hero of the first order who braves his tormentors, who provokes them to employ all their art, and who considers as his chief glory to bear the greatest degree of pain without shrinking (See AMERICA, n^o 14, 27, 28, 29). The recital of their tortures would appear exaggerated, if it were not attested by the best authority, and if the savage nations among whom those customs are established were not sufficiently known; but the excess of the cruelty is not so astonishing as the courage of the victim. The European exposed to sufferings of the same dreadful nature would rend heaven and earth with his piercing cries and horrible groans; the reward of martyrdom, the prospect of eternal life, could alone give him fortitude to endure such torments; but the savage is not animated with this exalted hope. What supports him then in scenes of so exquisite suffering? The feeling of shame, the fear of bringing reproach on his tribe, and giving a stain to his fellows never to be wiped away, are the only sentiments which influence the mind of a savage, and which always, present to his imagination, animate him, support him, and lend him spirit and resolution. At the same time, however powerful those motives may be, they would not be alone sufficient, if the savage felt pain in the same degree with the European. Sensibility, as we have already observed, is increased by education; it is influenced by society, manners, laws, and government; climate and food work it into a hundred different shapes; and all the physical and moral causes contribute to increase and diminish it. The habitual existence of a savage would be a state of suffering to an inhabitant of Europe. You must cut the flesh of the one and tear it away with your nails, before you can make him feel in an equal degree to a scratch or prick of a needle in the other. The savage, doubtless, suffers under torture, but he suffers much less than an European in the same circumstances: the reason is obvious; the air which the savages breathe is loaded with fog and moist vapours; their rivers not being confined by high banks, are by the winds as well as in floods spread over the level fields, and deposite on them a putrid and pernicious slime; the trees squeezed one upon another, in that rude uncultivated country serve rather as a covering to the earth than an ornament. Instead of those fresh and delicious shades, those openings in the woods, and walks crossing

H 2

each

(A) There are instances of persons who have died at the noise of thunder without being touched. A man frightened with the fall of a gallery in which he happened to be, was immediately seized with the black jaundice. M. le Cat mentions a young person on whom the influence of no other made such an impression, that his countenance became at first yellow, and then changed into black, in such a manner that in less than eight days he appeared to wear a mask of black velvet: he continued in this state for four months without any other symptom of bad health or any pain. A sailor was so terrified in a storm, that his face sweated blood, which like ordinary sweat returned as it was wiped off. Stahl, whose testimony cannot be called in question, cites a similar case of a girl who had been frightened with soldiers. The excess of fear, according to many physicians, produces madness and epilepsy.

Pleasure.

each other in all directions, which delight the traveller in the fine forests of France and Germany; those in America serve only to intercept the rays of the sun, and to prevent the benign influence of his beams. The savage participates of this cold humidity; his blood has little heat, his humours are gross, and his constitution phlegmatic. To the powerful influence of climate, it is necessary to join the habits of his life. Obligated to traverse vast deserts for subsistence, his body is accustomed to fatigue; food not nourishing, and at the same time in no great plenty, blunts his feelings; and all the hardships of the savage state give a rigidity to his members which makes him almost incapable of suffering. The savage in this state of nature may be compared to our water-women and street-porters, who, though they possess neither great vigour nor strength, are capable of performing daily, and without complaint, that kind of labour which to a man in a different condition of life would be a painful and grievous burden. Feeling, in less perfection with the savage, by the effects of climate and food, and the habits of his life, is still farther restrained by moral considerations. The European is less a man of nature than of society: moral restraints are powerful with him; while over the American they have scarcely any influence. This latter then is in a double condition of imperfection with regard to us; his senses are blunted, and his moral powers are not disclosed. Now, pleasure and pain depending on the perfection of the senses and the unfolding of the intellectual faculties, it cannot be doubted, that in enjoyments of any kind savages experience less pleasure, and in their suffering less pain, than Europeans in the same circumstances. And in fact, the savages of America possess a very feeble constitution. They are agile without being strong; and this agility depends more on their habits than on the perfection of their members: they owe it to the necessity of hunting; and they are moreover so weak, that they were unable to bear the toil which their first oppressors imposed on them. Hence a race of men in all respects so imperfect could not endure torment under which the most robust European would sink, if the pain which they feel were really as great as it appears to be. Feeling is then, and must necessarily be, less in the savage condition; for this faculty disclosing itself by the exercise of all the physical and moral qualities, must be less as they are less exercised. Every thing shows the imperfection of this precious quality, this source of all our affections, in the American savages.

"All the improvements in Europe have had a tendency to unfold sensibility: the air is purified that we may breathe more freely; the morasses are drained, the rivers are regulated in their courses, the food is nourishing, and the houses commodious. With the savages, on the contrary, every thing tends to curb it; they take pleasure even in hardening the organs of the body, in accustoming themselves to bear by degrees the most acute pain without complaining. Boys and girls among

the savages amuse themselves with tying their naked arms together, and laying a kindled coal between them, to try which of them can longest suffer the heat; and the warriors who aspire to the honour of being chief, undergo a course of suffering which exceeds the idea of torture inflicted on the greatest criminals in Europe."

These observations on the pleasures and pains of savages appear to be well-founded, and, as the attentive reader will perceive, are perfectly agreeable to the theory of Dr Sayers. If indeed that theory be just, as we believe it to be, it will follow, that the few pleasures of sense which the American enjoys, he ought to enjoy more completely than any European, because to him they recur but seldom. This may very possibly be the case; and certainly would be so, were not his fibres, by climate and the habits of his life, rendered more rigid than those of the civilized part of the inhabitants of Europe. But if we agree with our author in what he says of the pains and pleasures of savages, we cannot admit, without many exceptions, his theory of the enjoyments of children. It is so far from being true, that few things amuse, and that nothing satisfies them, that the direct contrary must have been observed by every man attentive to the operations of the infant mind, which is amused with every thing new, and often completely satisfied with the merest trifle. The pleasures of philosophy are not indeed unfolded to the infant; but it by no means follows that he does not enjoy his rattle and his drum as much as the philosopher enjoys his telescope and air-pump; and if there be any truth in the science of physiognomy, the happiness of the former is much more pure and exquisite than that of the latter. That the most perfect music is vain noise to an infant, is far from being self-evident, unless the author confines the state of infancy to a very few months; and we are not disposed to believe, without better proof than we have yet received, that the relish of exquisite perfumes and highly-seasoned dishes adds much to the sum of human felicity.

But however much we disapprove of many of these reflections, the following we cordially adopt as our own. "If we compare (says our author) the pleasures of sense with those which are purely intellectual, we shall find that the latter are infinitely superior to the former, as they may be enjoyed at all times and in every situation of life. What are the pleasures of the table, says Cicero, of gaming, and of women, compared with the delights of study? This taste increases with age, and no happiness is equal to it. Without knowledge and study, says Cato, life is almost the image of death (B). The pleasures of the soul are such, that it is frequent enough to see men preserve their gaiety during their whole life, notwithstanding a weak, diseased, and debilitated body. Scaron, who lived in the last century, was an example of this. Balzac, speaking of him, says, that Prometheus, Hercules, and Philoctetes, in profane, and Job in sacred, history, said many great things while they

(B) "Savages, barbarians, and peasants, enjoy little happiness except that of sensation. The happiness of a civilized and well-informed man consists of sensations, of ideas, and of a great number of affinities, altogether unknown to them. He not only enjoys the present, but the past and the future. He recalls the agreeable idea of pleasures which he has tasted. It is great happiness, says an ancient, to have the recollection of good actions, of an upright intention, and of promises which we have kept."

leasure. they were afflicted with violent pain, but Scaron alone said pleasant things. I have seen, continues he, in many places of ancient history, constancy, and modesty, and wisdom, and eloquence, accompanying affliction, but he is the only instance wherein I have seen pleafantry.

"There are men whose understandings are constantly on the stretch, and by this very means they are improved; but if the body were as constantly employed in the pursuit of sensual gratification, the constitution would soon be destroyed. The more we employ the mind we are capable of the greater exertion; but the more we employ the body we require the greater repose. There are besides but some parts of the body capable of enjoying pleasure; every part of it can experience pain. A toothach occasions more suffering than the most considerable of our pleasures can procure of enjoyment. Great pain may continue for any length of time; excessive pleasures are almost momentary. Pleasure carried to an extreme becomes painful; but pain, either by augmenting or diminishing it, never becomes agreeable. For the moment, the pleasures of the senses are perhaps more satisfactory; but in point of duration those of the heart and mind are infinitely preferable. All the sentiments of tenderness, of friendship, of gratitude, and of generosity, are sources of enjoyment for man in a state of civilization. The damned are exceedingly unhappy, said St Catherine de Sienna, if they are incapable of loving or being beloved.

"Pleasure, continued for a great length of time, produces languor and fatigue, and excites sleep; the continuation of pain is productive of none of these effects. Many suffer pain for eight days and even a month without interruption; an equal duration of excessive pleasure would occasion death.

"Time is a mere relative idea with regard to pleasure and pain; it appears long when we suffer, and short when we enjoy. If there existed no regular and uniform movement in nature, we would not be able from our sensations alone to measure time with any degree of exactness, for pain lengthens and pleasure abridges it. From the languor of unoccupied time has arisen the proverb expressive of our desire to *kill* it. It is a melancholy reflection, and at the same time true, that there is no enjoyment which can effectually secure us from pain for the remainder of our lives; while there are examples of evils which hold men in constant sorrow and pain during their whole existence. Such then is the imperfection of the one and the power of the other.

"Pleasure and pain are the sources of morality; an action is just or unjust, good or otherwise, only as its natural tendency is to produce suffering or enjoyment to mankind. No crime could be committed against a being altogether insensible, nor could any good be bestowed on it. Unless he were endowed with the desire of pleasure and the apprehension of pain, man, like an automaton, would act from necessity, without choice and without determination.

"All our passions are the developement of sensibility. If we were not possessed of feeling, we should be destitute of passions; and as sensibility is augmented by civilization, the passions are multiplied; more active and vigorous in an extensive and civilized empire than in a small state; more in the latter than among barbarous nations; and more in these last than among savages (See

PASSION). There are more passions in France and England than in all the nations of Europe; because every thing which serves to excite and foster them is always in those countries in the greatest state of fermentation. The mind is active; the ideas great, extensive, and multiplied. And is it not the soul, the mind, and heart, which are the focus of all the passions?"

But wherever the passions are multiplied, the sources of pleasure and pain are multiplied with them. This being the case, it is impossible to prescribe a fixed and general rule of happiness suited to every individual. There are objects of pleasure with regard to which all men of a certain education are agreed; but there are perhaps many more, owing to the variety of tempers and education, about which they differ. Every man forms ideas of enjoyment relative to his character; and what pleases one may be utterly detested by another. In proportion as a nation is civilized and extensive, those differences are remarkable. Savages, who are not acquainted with all the variety of European pleasures, amuse themselves with very few objects. Owing to the want of civilization, they have scarcely any choice in the objects of taste. They have few passions; we have many. But even in the nations of Europe pleasure is infinitely varied in its modification and forms. Those differences arise from manners, from governments, from political and religious customs, and chiefly from education. Meanwhile, however different and variable the ideas of pleasure may be among nations and individuals, it still remains a fact, that a certain number of persons in all civilized states, whether distinguished by birth, or rank, or fortune, or talents, as they have nearly the same education so they form nearly the same ideas of happiness: but to possess it, a man must give his chief application to the state of his mind; and notwithstanding all his efforts it is of uncertain duration. Happiness is the sunshine of life: we enjoy it frequently at great intervals; and it is therefore necessary to know how to use it. All the productions of art perish; the largest fortunes are dissipated; rank, honour, and dignity pass away like a fleeting shadow; the memory is impaired; all the faculties of the soul are extinguished; the body sinks under the infirmities of old age; and scarcely has one reached the boundaries of happiness marked out by his imagination, when he must give place to another, and renounce all his pleasures, all his hopes, all his illusions; the fugitive images of which had given happiness to the mind.

There are pleasures, however, on which the mind may securely rest, which elevate man above himself, dignify his nature, fix his attention on spiritual things, and render him worthy of the care of Providence. These are to be found in true religion; which procures for those who practise its duties inexpressible happiness in a better country, and is in this world the support of the weak, and the sweet consolation of the unfortunate.

PLEBEIAN, any person of the rank of the common people. It is chiefly used in speaking of the ancient Romans, who were divided into senators, patricians, and plebeians. The distinction was made by Romulus the founder of the city; who confined all dignities, civil, military, and sacerdotal, to the rank of patricians. But to prevent the seditions which such a distinction might produce through the pride of the higher order and the envy of the lower, he endeavoured to engage them

Pleasure,
Plebeian.

Plectranthus, them to one another by reciprocal ties and obligations. Every plebeian was allowed to choose, out of the body of the patricians, a protector, who should be obliged to assist him with his interest and substance, and to defend him from oppression. These protectors were called *patrons*; the protected, *clients*. It was the duty of the patron to draw up the contracts of the clients, to extricate them out of their difficulties and perplexities, and to guard their ignorance against the artfulness of the crafty. On the other hand, if the patron was poor, his clients were obliged to contribute to the portions of his daughters, the payment of his debts, and the ransom of him and his children if they happened to be taken in war. The client and patron could neither accuse nor bear witness against each other; and if either of them was convicted of having violated this law, the crime was equal to that of treason, and any one might with impunity slay the offender as a victim devoted to Pluto and the infernal gods. For more than 600 years we find no dissensions nor jealousies between the patrons and their clients; not even in the times of the republic, when the people frequently mutinied against the great and powerful.

PLECTRANTHUS, in botany: A genus of the gymnospermia order, belonging to the didynamia class of plants; and in the natural method ranking under the 42d order, *Verticillatæ*. The calyx is monophyllous, short, and bilabiate; the upper lip of which is large, oval, and bent upwards; the inferior lip is quadrisid, and divided into two lacinie: the corolla is monopetalous, ringent, and turned back; the labiæ look different ways, and from the base of the tube there is a nectarium like a spur: the filaments are in a declining situation, with simple antheræ: the stylus filiform; the stigma bifid. It has four seeds covered only by the calyx. There are two species, viz. 1. The *fruticosus*, a native of the Cape of Good Hope; 2. *Punctatus*, a native of Africa. The first flowers from June to September, the latter from January to May.

PLEDGE (*Plegius*), in common law, a surety or gage, either real or personal, which the plaintiff or demandant is to find for his prosecuting the suit.

The word is sometimes also used for *FRANK Pledge*, which see.

To PLEDGE, in drinking, denotes to warrant, or be surety to one, that he shall receive no harm while he is taking his draught. The phrase is referred by our antiquaries to the practice of the Danes, heretofore in England, who frequently used to stab or cut the throats of the natives while they were drinking.

PLEDGES of Goods for money. See **PAWN**.

PLEDGERY, or **PLEGGERY**, in law, suretiship, or an undertaking or answering for another.

PLEDGET, **BOLSTER**, or *Compress*, in surgery, a kind of flat tent laid over a wound, to imbibe the superfluous humours, and to keep it clean.

PLEIADES, in fabulous history, the seven daughters of Atlas king of Mauritania and Pleione, were thus called from their mother. They were Maia, Electra, Taygete, Asterope, Merope, Halcyone, and Celæno; and were also called *Atlantides*, from their father Atlas. These princesses were carried off by Buisiris king of Egypt; but Hercules having conquered him, delivered them to their father: yet they afterwards suffered a new persecution from Orion, who pursued them five years,

till Jove, being prevailed on by their prayers, took them up into the heavens, where they form the constellation which bears their name.

PLEIADES, in astronomy, an assemblage of seven stars, in the neck of the constellation Taurus.

They are thus called from the Greek *πλεῖν*, *navigare*, "to sail;" as being terrible to mariners, by reason of the rains and storms that frequently rise with them. The Latins called them *vergilia*, from *ver*, "spring;" because of their rising about the time of the vernal equinox. The largest is of the third magnitude, and is called *lucida pleiadum*.

PLENARY, something complete or full. Thus we say the pope grants *plenary* indulgences; *i. e.* full and entire remissions of the penalties due to all sins. See **INDULGENCES**.

PLENIPOTENTIARY, a person vested with full power to do any thing. See **AMBASSADOR**.

PLENITUDE, the quality of a thing that is full, or that fills another. In medicine, it chiefly denotes a redundancy of blood and humours.

PLENUM, in physics, denotes, according to the Cartesians, that state of things wherein every part of space is supposed to be full of matter, in opposition to a **VACUUM**, which is a space supposed devoid of all matter.

PLENUS FLOS, a full flower; a term expressive of the highest degree of luxuriance in flowers. See **BOTANY**, p. 428, 2d column. Such flowers, although the most delightful to the eye, are both vegetable monsters, and, according to the sexualists, vegetable eunuchs; the unnatural increase of the petals constituting the first; the consequent exclusion of the stamina or male organs, the latter. The following are well known examples of flowers with more petals than one; ranunculus, anemone, marsh-marygold, columbine, fennel-flower, poppy, peony, pink, gilliflower, campion, viscous campion, lily, crown imperial, tulip, narcissus, rocket, mallow, Syrian mallow, apple, pear, peach, cherry, almond, myrtle, rose, and strawberry.

Flowers with one petal are not so subject to fullness. The following, however, are instances: polianthus, hyacinth, primrose, crocus, meadow-saffron, and thorn-apple, tho' Kramer has asserted that a full flower with one petal is a contradiction in terms. In flowers with one petal, the mode of luxuriance, or impletion, is by a multiplication of the divisions of the limb or upper part; in flowers with more petals than one, by a multiplication of the petals or nectarium.

To take a few examples. Columbine is rendered full in three different ways: 1. By the multiplication of its petals, and total exclusion of the nectaria; 2. By the multiplication of the nectaria, and exclusion of the petals; or, 3. By such an increase of the nectaria only as does not exclude the petals, between each of which are interjected three nectaria, placed one within another. Again, fennel-flower is rendered full by an increase of the nectaria only; narcissus, either by a multiplication of its cup and petals, or of its cup only; lark-spur commonly by an increase of the petals and exclusion of the spur, which is its nectarium. In *saponaria concava anglica*, the impletion is attended with the singular effect of incorporating the petals, and reducing their number from five to one; and in gelder-rose, the luxuriance is effected by an increase both in magnitude and number of

Pleides
||
Plenus.

tenus. of the circumference or margin of the head of flowers, in the plain, wheel-shaped, barren florets; and an exclusion of all the bell-shaped hermaphrodite florets of the centre or disk.

Hitherto we have treated of plenitude in simple flowers only: the instance just now adduced seems to connect the different modes of impletion in them and compound flowers. Before proceeding farther, however, it will not be improper to premise, that as a simple luxuriant flower is frequently, by beginners, mistaken for a compound flower in a natural state, such flowers may always be distinguished with certainty by this rule; That in simple flowers, however luxuriant, there is but one pistillum or female organ; whereas in compound flowers, each floret, or partial flower, is furnished with its own proper pistillum. Thus in hawk-weed, a compound flower, each flat or tongue-shaped floret in the aggregate has its five stamina and naked seed, which last is in effect its pistillum; whereas, in a luxuriant lychnis, which is a simple flower, there is found only one pistillum or female organ common to the whole.

In a compound radiated flower, which generally consists of plain florets in the margin or radius, and tubular or hollow florets in the centre or disk; plenitude is effected either by an increase of the florets in the margin, and a total exclusion of those in the disk; which mode of luxuriance is termed *impletion by the radius*, and resembles what happens in the gelder-rose: or by an elongation of the hollow florets in the centre, and a less profound division of their brims; which is termed *impletion by the disk*. In the first mode of luxuriance, the florets in the centre, which are always hermaphrodite or male, are entirely excluded; and in their place succeed florets similar in sex to those of the radius. Now, as the florets in the margin of a radiated compound flower are found to be always either female, that is, furnished with the pistillum only; or neuter, that is, furnished with neither stamina nor pistillum; it is evident, that a radiated compound flower, filled by the radius, will either be entirely female, as in feverfew, daisy, and African marigold; or entirely neuter, as in sunflower, marygold, and centaury: hence it will always be easy to distinguish such a luxuriant flower from a compound flower with plain florets in a natural state; as these flowers are all hermaphrodite, that is, furnished with both stamina and pistillum. Thus the full flowers of African marigold have each floret furnished with the pistillum or female organ only: the natural flowers of dandelion, which, like the former, is composed of plain florets, are furnished with both stamina and pistillum.

In the second mode of luxuriance, termed *impletion by the disk*, the florets in the margin sometimes remain unchanged: but most commonly adopt the figure of those in the centre, without, however, suffering any alteration in point of sex; so that confusion is less to be apprehended from this mode of luxuriance than from the former; besides, the length to which the florets in the centre run out is of itself a sufficient distinction, and adapted to excite at once an idea of luxuriance. Daisy, feverfew, and African marigold, exhibit instances of this as well as of the former mode of impletion.

In luxuriant compound flowers with plain florets, the *semiflosculosi* of Tournefort, the stigma or summit of the style in each floret is lengthened, and the seed-buds are enlarged and diverge; by which characters such flowers

may always be distinguished from flowers of the same kind in a natural state. Scorzonera, nipple-wort, and goat's-beard, furnish frequent instances of the plenitude alluded to.

Lastly, the impletion of compound flowers with tubular or hollow florets, the *flosculosi* of Tournefort, seems to observe the same rules as that of radiated flowers just delivered. In everlasting-flower, the *xeranthemum* of Linnaeus, the impletion is singular, being effected by the enlargement and expansion of the inward chaffy scales of the calyx. These scales, which become coloured, are greatly augmented in length, so as to overtop the florets, which are scarce larger than those of the same flower in a natural state. The florets too in the margin, which in the natural flower are female, become, by luxuriance, barren; that is, are deprived of the pistillum; the style, which was very short, spreads, and is of the length of the chaffy scales; and its summits, formerly two in number, are metamorphosed into one.

Full flowers are more easily referred to their respective genera in methods founded upon the calyx, as the flower-cup generally remains unaffected by this highest degree of luxuriance.

PLEONASM, a figure in rhetoric, whereby we use words seemingly superfluous, in order to express a thought with the greater energy; such as, "I saw it with my own eyes," &c. See ORATORY, n° 67.

PLESCOW, a town of Russia, capital of a duchy of the same name, with an archbishop's see, and a strong castle. It is a large place, and divided into four parts, each of which is surrounded with walls. It is seated on the river Muldow, where it falls into the lake Plefcow, 80 miles south of Narva, and 150 south by west of Peterburg. E. Long. 27. 52. N. Lat. 57. 58.

PLESCOW, a duchy in Russia, between the duchies of Novogorod, Lithuania, Livonia, and Ingria.

PLESSIS-LES-TOURS, a royal palace of France, within half a league of Tours. It was built by Louis XI. and in it he died in the year 1483. It is situated in a plain surrounded by woods, at a small distance from the Loire. The building is yet handsome, though built of brick, and converted to purposes of commerce.

PLETHORA, in medicine, from πλεθος, "plenitude." A plethora is when the vessels are too much loaded with fluids. The plethora may be sanguine or serous. In the first there is too much crassamentum in the blood, in the latter too little. In the sanguine plethora, there is danger of a fever, inflammation, apoplexy, rupture of the blood-vessels, obstructed secretions, &c.: in the serous, of a dropsy, &c. A rarefaction of the blood produces all the effects of a plethora; it may accompany a plethora, and should be distinguished therefrom. Mr Bromfield observes, that a sanguine plethora may thus be known to be present by the pulse. An artery overcharged with blood is as incapable of producing a strong full pulse, as one that contains a deficient quantity; in both cases there will be a low and weak pulse. To distinguish rightly, the pulse must not be felt with one or two fingers on the carpal artery; but if three or four fingers cover a considerable length of the artery, and we press hard for some time on it, and then suddenly raise all these fingers except that which is nearest to the patient's hand, the influx of the blood, if there is a plethora, will be so rapid as to raise the other finger, and make us sensible of the fulness. The sanguine

Pleonasma
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Plethora.

Pleura
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Pleuro-
nectes.

sanguine plethora is relieved by bleeding: the ferous by purging, diuretics, and sweating. See MEDICINE, n^o 100.

PLEURA, in anatomy, a thin membrane covering the inside of the thorax. See ANATOMY, n^o 113.

PLEURITIS, or PLEURISY. See MEDICINE, n^o 185.

PLEURONECTES, in ichthyology, a genus belonging to the order of thoracici. Both eyes are on the same side of the head; there are from four to five rays in the gill-membrane; the body is compressed; the one side resembling the back, the other the belly. There are 17 species; the most remarkable are,

1. The hypoglossus, or holibut. This is the largest of the genus: some have been taken in our seas weighing from 100 to 300 pounds; but much larger are found in those of Newfoundland, Greenland, and Iceland, where they are taken with a hook and line in very deep water. They are part of the food of the Greenlanders, who cut them into large slips, and dry them in the sun. They are common in the London markets, where they are exposed to sale cut into large pieces. They are very coarse eating, excepting the part which adheres to the side fins, which is extremely fat and delicious, but surfeiting. They are the most voracious of all flat fish. There have been instances of their swallowing the lead weight at the end of a line, with which the seamen were sounding the bottom from on board a ship. The holibut, in respect to its length, is the narrowest of any of this genus except the sole. It is perfectly smooth, and free from spines either above or below. The colour of the upper part is dusky; beneath, of a pure white. We do not count the rays of the fins in this genus; not only because they are so numerous, but because nature hath given to each species characters, independent of these rays, sufficient to distinguish them by. These flat fish swim sidewise; for which reason Linnaeus hath styled them *pleuronectes*.

2. The platea, or plaice, are very common on most of our coasts, and sometimes taken of the weight of 15 pounds; but they seldom reach that size, one of eight or nine pounds being reckoned a large fish. The best and largest are taken off Rye on the coast of Sussex, and also off the Dutch coasts. They spawn in the beginning of February. They are very flat, and much more square than the preceding. Behind the left eye is a row of six tubercles, that reaches to the commencement of the lateral line. The upper part of the body and fins are of a clear brown, marked with large bright orange-coloured spots: the belly is white.

3. The stenus, or flounder, inhabits every part of the British sea, and even frequents our rivers at a great distance from the salt waters; and for this reason some writers call it the *passer fluviatilis*. It never grows large in our rivers, but is reckoned sweeter than those that live in the sea. It is inferior in size to the plaice, seldom or never weighing more than six pounds. It may very easily be distinguished from the plaice, or any other fish of this genus, by a row of sharp small spines that surround its upper sides, and are placed just at the junction of the fins with the body. Another row marks the side-line, and runs half way down the back. The colour of the upper part of the body is a pale brown, sometimes marked with a few obscure spots of dirty yellow; the belly is white.

4. The limanda, or dab, is found with the other species, but is less common. It is in best season during February, March, and April: they spawn in May and June, and become flabby and watery the rest of summer. They are superior in quality to the plaice and flounder, but far inferior in size. It is generally of an uniform brown colour on the upper side, though sometimes clouded with a darker. The scales are small and rough, which is a character of this species. The lateral line is extremely incurvated at the beginning, then goes quite straight to the tail. The lower part of the body is white.

5. The solea, or sole, is found on all our coasts; but those on the western shores are much superior in size to those on the north. On the former they are sometimes taken of the weight of six or seven pounds, but towards Scarborough they rarely exceed one pound; if they reach two, it is extremely uncommon. They are usually taken in the trawl-net: they keep much at the bottom, and feed on small shell-fish. It is of a form much more narrow and oblong than any other of the genus. The irides are yellow; the pupils of a bright sapphire colour: the scales are small, and very rough: the upper part of the body is of a deep brown; the tip of one of the pectoral fins black; the under part of the body white; the lateral line is straight; the tail rounded at the end. It is a fish of a very delicate flavour; but the small soles are in this respect much superior to large ones. By the ancient laws of the Cinque Ports, no one was to take soles from the 1st of November to the 15th of March; neither was any body to fish from sun-setting to sun-rising, that the fish might enjoy their night-food. The chief fishery for them is at Brixham in Torbay.

6. The maximus, or turbot, grows to a very large size: Mr Pennant has seen them of 23 pounds weight, but has heard of some that weighed 30. The turbot is of a remarkable square form: the colour of the upper part of the body is cinereous, marked with numbers of black spots of different sizes: the belly is white; the skin is without scales, but greatly wrinkled, and mixed with small short spines, dispersed without any order.—These fish are taken chiefly off the north coast of England, and others off the Dutch coast. See *TURBOT FISHERY*.

PLEURS, a town in France, which was buried under a mountain in the year 1618. See our article MOUNTAIN, p. 430. Of this fatal circumstance, Bishop Burnet, in his Travels, p. 96. gives the following account. "Having mentioned (says the Bishop) some falls of mountains in these parts (viz. near the Alps), I cannot pass by the extraordinary fate of the town of Pleurs, about a league from Chavennes to the north.—The town was half the bigness of Chavennes, but much more nobly built; for, besides the great palace of the Francken, that cost some millions, there were many other palaces built by rich factors both of Milan and the other parts of Italy, who, liking the situation and air, as well as the freedom of the government, gave themselves all the indulgences that a vast wealth could furnish. By one of the palaces that was a little distant from the town, and was not overwhelmed with it, one may judge of the rest. It was an out-house of the family of the Francken, and yet it may compare with many palaces in Italy. The voluptuousness of this place be-

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Pleur

came very crying; and Madam de Salis told me that she heard her mother often relate some passages of a Protestant minister's sermons that preached in a little church there, who warned them often of the terrible judgments of God which were hanging over their heads, and which he believed would suddenly break out upon them.

"On the 25th of August 1628, an inhabitant came and told them to be gone, for he saw the mountains cleaving; but he was laughed at for his pains. He had a daughter whom he persuaded to leave all and go with him; but when she was safe out of town, she called to mind that she had not locked the door of a room in which she had some things of value, and so she went back to do that, and was buried with the rest; for at the hour of supper the hill fell down, and buried the town and all the inhabitants, to the number of 2200, so that not one person escaped. The fall of the mountains did so fill the channel of the river, that the first news those of Chavennes had of it was by the failing of their river; for three or four hours there came not a drop of water, but the river wrought for itself a new course, and returned to them.

"I could hear no particular character of the man who escaped (continues the Bishop); so I must leave the secret reason of so singular a preservation to the great discovery, at the last day, of those steps of Divine Providence that are now so unaccountable. Some of the family of the Francken got some miners to work under ground, to find out the wealth that was buried in their house; for, besides their plate and furniture, there was a great deal of cash and many jewels in the house. The miners pretended they could find nothing; but they went to their country of Tirol and built fine houses, and a great wealth appeared, of which no other visible account could be given but this, that they had found some of that treasure."

PLEXUS, among anatomists, a bundle of small vessels interwoven in the form of net-work: thus a congeries of vessels within the brain is called *plexus choroides, reticularis, or retiformis*. See ANATOMY, n^o 136.

A plexus of nerves is an union of two or more nerves, forming a sort of ganglion or knot.

PLICA POLONICA, or *painted hair*, is a disease peculiar to Poland; whence the name. See MEDICINE, n^o 355. Mr Coxe, who gives a short account of it, attempts likewise to give the physical causes of it. Many causes of this kind, he tells us, have been supposed to concur in rendering the plica more frequent in those regions than in other parts. It would be an endless work to enumerate the various conjectures with which each person has supported his favourite hypothesis.—The most probable are those assigned by Dr Vicat: The first cause is the nature of the Polish air, which is rendered insalubrious by numerous woods and morasses, and occasionally derives an uncommon keenness even in the midst of summer from the position of the Carpathian mountains; for the southern and south-easterly winds, which usually convey warmth in other regions, are in this chilled in their passage over their snowy summits. The second is, unwholesome water; for although Poland is not deficient in good springs, yet the common people usually drink that which is nearest at hand, taken indiscriminately from rivers, lakes, and even stag-

nant pools. The third cause is the gross inattention of the natives to cleanliness; for experience shows, that those who are not negligent in their persons and habitations, are less liable to be afflicted with the plica than others who are deficient in that particular. Thus persons of higher rank are less subject to this disorder than those of inferior stations; the inhabitants of large towns than those of small villages; the free peasants than those in an absolute state of vassalage; the natives of Poland Proper than those of Lithuania. Whatever we may determine as to the possibility that all or any of these causes, by themselves, or in conjunction with others, originally produced the disorder; we may venture to assert, that they all, and particularly the last, assist its propagation, inflame its symptoms, and protract its cure.

In a word, the plica polonica appears to be a contagious distemper; which, like the leprosy, still prevails among a people ignorant in medicine, and inattentive to check its progress, but is rarely known in those countries where proper precautions are taken to prevent its spreading.

PLIMPTON, a town of Devonshire, in England, with a market on Saturdays. It is seated on a branch of the river Plime, and had once a castle, now in ruin. It sends two members to parliament; is seven miles E. of Plymouth, and 218 W. by S. of London. W. Long. 4. c. N. Lat. 50. 22.

PLINIA, in botany; a genus of plants of the polyandria monogynia class, described by Plumier and Linnæus. The empalement is divided into five segments; the flower consists of five petals; the stamina are numerous filaments, slender, and as long as the flower; the antheræ are small, and so is the germen of the pistil; the style is subulated, and of the length of the stamina; the stigma is simple; the fruit is a large globose berry, of a striated or sulcated surface, containing only one cell, in which is a very large, smooth, and globose seed. There is only one species.

PLINTH, ORLE, or *Orlo*, in architecture, a flat square member, in the form of a brick. It is used as the foundation of columns, being that flat square table under the moulding of the base and pedestal at the bottom of the whole order. It seems to have been originally intended to keep the bottom of the original wooden pillars from rotting. Vitruvius also calls the Tuscan abacus *plinth*.

PLINTH of a Statue, &c. is a base, either flat, round, or square, that serves to support it.

PLINTH of a Wall, denotes two or three rows of bricks advancing out from a wall; or, in general, any flat high moulding, that serves in a front-wall to mark the floors, to sustain the caves of a wall, or the larmier of a chimney.

PLINY the ELDER, or *Cæcilius Plinius Secundus*, one of the most learned men of ancient Rome, was descended from an illustrious family, and born at Verona. He bore arms in a distinguished post; was one of the college of Augurs; became intendant of Spain; and was employed in several important affairs by Vespasian and Titus, who honoured him with their esteem. The eruption of Mount Vesuvius, which happened in the year 79, proved fatal to him. His nephew, Pliny the Younger, relates the circumstances of that dreadful eruption, and the death of his uncle, in a letter to Tacitus.

Plimpton
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Pliny.

citus. Pliny the Elder wrote a Natural History in 37 books, which is still extant, and has had many editions; the most esteemed of which is that of Father Hardouin, printed at Paris in 1723, in two volumes folio.

PLINY the Younger, nephew of the former, was born in the ninth year of Nero, and the 62d of Christ, at Novocomum, a town upon the lake Larius, near which he had several beautiful villas. Cæcilius was the name of his father, and Plinius Secundus that of his mother's brother, who adopted him. He brought into the world with him fine parts and an elegant taste, which he did not fail to cultivate early; for, as he tells us himself, he wrote a Greek tragedy at 14 years of age. He lost his father when he was young; and had the famous Virginius for his tutor or guardian, whom he has set in a glorious light. He frequented the schools of the rhetoricians, and heard Quintilian; for whom he ever after entertained so high an esteem, that he bestowed a considerable portion upon his daughter at her marriage. He was in his 18th year when his uncle died; and it was then that he began to plead in the forum, which was the usual road to dignities. About a year after, he assumed the military character, and went into Syria with the commission of tribune: but this did not suit his taste any more than it had done Tully's; and therefore we find him returning after a campaign or two. He tells us, that in his passage homewards he was detained by contrary winds at the island Icaria, and how he employed himself in making verses: he enlarges in the same place upon his poetical exertations; yet poetry was not the shining part of his character any more than it had been of Tully's.

Upon his return from Syria, he married a wife, and settled at Rome: it was in the reign of Domitian. During this most perilous time, he continued to plead in the forum, where he was distinguished not more by his uncommon abilities and eloquence, than by his great resolution and courage, which enabled him to speak boldly, when scarcely one else durst speak at all. On these accounts he was often singled out by the senate to defend the plundered provinces against their oppressive governors, and to manage other causes of a like important and dangerous nature. One of these was for the province of Bœtica, in their prosecution of Bæbius Massa; in which he acquired so general an applause, that the emperor Nerva, then a private man, and in banishment at Tarentum, wrote to him a letter, in which he congratulated not only Pliny, but the age which had produced an example so much in the spirit of the ancients. Pliny relates this affair in a letter to Cornelius Tacitus; and he was so pleased with it himself, that he could not help intreating this friend to record it in his history. He intreats him, however, with infinitely more modesty than Tully had intreated Lucceius upon the same occasion: and though he might imitate Cicero in the request, as he professes to have constantly set that great man before him for a model, yet he took care not to transgress the bounds of decency in his manner of making it. He obtained the offices of questor and tribune, and luckily went unhurt through the reign of Domitian: there is, however, reason to suppose, if that emperor had not died just as he did, that Pliny would have shared the fate of many other great men; for he tells us himself, that his name was afterwards found in

Domitian's tablets, among the number of those who were destined to destruction.

He lost his wife in the beginning of Nerva's reign, and soon after married his beloved Calphurnia, of whom we read so much in his Epistles. He had not, however, any children by any of his wives: and hence we find him thanking Trajan for the *jus trium liberorum*, which he afterwards obtained of that emperor for his friend Suetonius Tranquillus. He hints also, in his letter of thanks to Trajan, that he had been twice married in the reign of Domitian. He was promoted to the consulate by Trajan in the year 100, when he was 38 years of age; and in this office pronounced that famous panegyric, which has ever since been admired, as well for the copiousness of the topics as the elegance of address. Then he was elected augur, and afterwards made proconsul of Bithynia; whence he wrote to Trajan that curious letter concerning the primitive Christians; which, with Trajan's rescript, is happily extant among his Epistles. Pliny's letter, as Mr Melmoth observes in a note upon the passage, is esteemed as almost the only genuine monument of ecclesiastical antiquity relating to the times immediately succeeding the apostles, it being written at most not above 40 years after the death of St Paul. It was preserved by the Christians themselves, as a clear and unsuspecting evidence of the purity of their doctrines, and is frequently appealed to by the early writers of the church against the calumnies of their adversaries. It is not known what became of Pliny after his return from Bithynia; whether he lived at Rome, or what time he spent at his country-houses. Antiquity is also silent as to the time of his death: but it is conjectured that he died either a little before or soon after that excellent prince, his admired Trajan; that is, about the year of Christ 116.

Pliny was one of the greatest wits, and one of the worthiest men, among the ancients. He had fine parts, which he cultivated to the utmost; and he accomplished himself with all the various kinds of knowledge which could serve to make him either useful or agreeable. He wrote and published a great number of things; but nothing has escaped the wreck of time except the books of Letters, and the panegyric upon Trajan. This has ever been considered as a masterpiece: and if he has, as some think, almost exhausted all the ideas of perfection in a prince, and gone perhaps a little beyond the truth, yet it is allowed that no panegyrist was ever possessed of a finer subject, and on which he might better indulge in all the flow of eloquence, without incurring the suspicion of flattery and lies. His letters seem to have been intended for the public; and in them he may be considered as writing his own memoirs. Every epistle is a kind of historical sketch, wherein we have a view of him in some striking attitude, either of active or contemplative life. In them are preserved anecdotes of many eminent persons, whose works are come down to us, as Suetonius, Silius Italicus, Martial, Tacitus, and Quintilian; and of curious things, which throw great light upon the history of those times. They are written with great politeness and spirit; and if they abound too much in turn and metaphor, we must impute it to that degenerate taste which was then accompanying the degenerate manners of Rome. Pliny, however, seems to have preserved

preserved himself in this latter respect from the general contagion: whatever the manners of the Romans were, his were pure and incorrupt. His writings breathe a spirit of transcendent goodness and humanity: his only imperfection is, he was too desirous that the public and posterity should know how humane and good he was. We have two elegant English translations of his Epistles; the one by Mr Melmoth, and the other by Lord Orrery.

PLOCAMA, in botany; a genus of the monogynia order, belonging to the pentandria class of plants. The calyx is quinqueentate; the fruit a berry and trilocular, with solitary seeds. Of this there is only one species, viz. the *pendula*, a native of the Canaries.

PLOCE. See ORATORY, p. 433.

PLOCKSKO, a town of Poland, and capital of a palatinate of the same name, with a castle and a bishop's see. The churches are very magnificent; and it is built upon a hill, whence there is a fine prospect every way, near the river Vistula. It is 25 miles south-east of Uladislaw, and 65 west of Warsaw. E. Long. 19. 29. N. Lat. 52. 46.

PLOCKSKO, a palatinate of Poland, bounded on the north by Regal Prussia, on the east by the palatinate of Mazovia, on the south by the Vistula, and on the west by the palatinate of Inowladislaw. The capital town is of the same name.

PLOEN is a town of Germany, in the circle of Lower Saxony, and capital of Holstein. It stands on the banks of a lake of the same name, and gave title to a duke, till by the death of the last duke Charles without male issue it escheated to the king of Denmark in 1761. The ducal palace, rising in the midst of the town, on an elevated spot of ground, and overlooking the lake, is a very picturesque object. The town stands 22 miles north-west of Lubeck, and 10 south-east of Kiell. E. Long. 10. 30. N. Lat. 54. 11.

PLOMO, in metallurgy, is a name given by the Spaniards, who have the care of the silver-mines, to the silver ore, when found adhering to the surface of stones, and when it incrusts their cracks and cavities like small and loose grains of gun-powder. Though these grains be few in number, and the rest of the stone have no silver in it, yet they are always very happy when they find it, as it is a certain token that there is a rich vein somewhere in the neighbourhood. And if in digging forwards they still meet with these grains, or the plomo in greater quantity, it is a certain sign that they are getting more and more near the good vein.

PLOT (Dr Robert), a learned antiquarian and philosopher, was born at Sutton-barn, in the parish of Borden in Kent, in the year 1641, and studied in Magdalen-hall, and afterwards in University-college, Oxford. In 1682 he was elected secretary of the Royal Society, and published the Philosophical Transactions from n° 143 to n° 166 inclusive. The next year Elias Ashmole, Esq; appointed him first keeper of his museum, and about the same time the vice-chancellor nominated him first professor of chemistry in the university of Oxford. In 1687 he was made secretary to the Earl Marshal, and the following year received the title of *Historiographer* to King James II. In 1690 he resigned his professorship of chemistry, and likewise his place of keeper of the museum, to which he presented a very large collection of natural curiosities; which were those he had described

in his histories of Oxfordshire and Staffordshire: the former published at Oxford in 1677, folio, and reprinted with additions and corrections in 1705; and the latter was printed in the same size in 1686. In January 1694-5, Henry Howard, Earl Marshal, nominated him Mobray-herald extraordinary; two days after which he was constituted register of the court of honour; and, on the 30th of April 1696, he died of the stone at his house in Borden.

As Dr Plot delighted in natural history, the above works were designed as essays towards a Natural History of England; and he had actually formed a design of travelling through England and Wales for that purpose. He accordingly drew up a plan of his scheme in a letter to the learned Bishop Fell; which is inserted at the end of the second volume of Leland's Itinerary, of the edition of 1744. Amongst several MSS. which he left behind him were large materials for the "Natural History of Kent, Middlesex, and the city of London." Besides the above works, he published *De origine fontium, tentamen philosophicum*, 8vo, and nine papers in the Philosophical Transactions.

PLOT, in dramatic poetry, is sometimes used for the fable of a tragedy or comedy; but more properly for the knot or intrigue, which makes the *embarras* of any piece. See POETRY.

PLOT, in surveying, the plan or draught of any field, farm, or manor, surveyed with an instrument, and laid down in the proper figure and dimensions.

PLOTINUS, a Platonic philosopher in the third century. He was born at Lycopolis, a city of Egypt, in 204; and began very early to show a great singularity both in his taste and manners: for, at eight years of age, when he went to school, he used to run to his nurse, and uncover her breast to suck; and would have continued that practice longer, if he had not been discouraged by her. At 28 years of age he had a strong desire to study philosophy, on which occasion he was recommended to the most famous professors of Alexandria. He was not satisfied with their lectures; but, upon hearing those of Ammonius, he confessed that this was the man he wanted. He studied for 11 years under that excellent master, and then went to hear the Persian and Indian philosophers: for in 243, when the emperor Gordianus intended to wage war against the Persians, he followed the Roman army, but probably repented of it; for it was with difficulty he could save his life by flight, after the emperor had been slain. He was then 39; and the year following he went to Rome, and read philosophical lectures in that city; but avoided following the example of Erennius and Origen, his fellow-pupils, who, having promised with him not to reveal some hidden and excellent doctrines they had received from Ammonius, had nevertheless forfeited their word. Plotinus continued ten years in Rome, without writing any thing; but, in his 50th year, Porphyry became his scholar; who, being of an exquisitely fine genius, was not satisfied with superficial answers, but required to have all difficulties thoroughly explained; and therefore Plotinus, to treat things with greater accuracy, was obliged to write more books. He had before written 21 books, and during the six years of Porphyry's stay with him he wrote 24, and 9 after Porphyry's leaving Rome, in all 54. The Romans had a high veneration for him; and he passed for a man of such judgment

Plotinus

ment and virtue, that many persons of both sexes, when they found themselves dying, intrusted him, as a kind of guardian angel, with the care of their estates and children. He was the arbiter of numberless law-suits; and constantly behaved with such humanity and rectitude of mind, that he did not create himself one enemy during the 26 years he resided in Rome. He, however, did not meet with the same justice from all of his own profession; for Olympias a philosopher of Alexandria, being envious of his glory, used his utmost endeavours, though in vain, to ruin him. The emperor Gallienus, and the empress Salonina, had a very high regard for him; and, had it not been for the opposition of some jealous courtiers, they would have had the city of Campania rebuilt, and given to him with the territory belonging to it, to establish a colony of philosophers, and to have it governed by the ideal laws of Plato's commonwealth. He laboured under various disorders during the last year of his life, which obliged him to leave Rome, when he was carried to Campania to the heirs of one of his friends, who furnished him with every thing necessary; and he died there in the year 270, at the age of 66, and in the noblest manner that an heathen philosopher could do, these being his words as he breathed his last: "I am labouring with all my might to return the divine part of me to that Divine Whole which fills the universe."

We have already remarked that the ideas of Plotinus were singular and extraordinary; and we shall now show that they were so. He was ashamed of being lodged in a body, for which reason he did not care to tell the place of his birth or family. The contempt he had for all earthly things, was the reason why he would not permit his picture to be drawn: and when his disciple Amelius was urgent with him upon this head, "Is it not enough (said he) to drag after us, whithersoever we go, that image in which nature has shut us up? Do you think that we should likewise transmit to future ages an image of that image, as a sight worthy of their attention?" From the same principle, he refused to attend to his health; for he never made use of preservatives or baths, and did not even eat the flesh of tame animals. He eat but little, and abstained very often from bread; which, joined to his intense meditation, kept him very much from sleeping. In short, he thought the body altogether below his notice; and had so little respect for it, that he considered it as a prison, from which it would be his supreme happiness to be freed. When Amelius, after his death, inquired about the state of his soul of the oracle of Apollo, he was told, "that it was gone to the assembly of the blessed, where clarity, joy, and a love of the union with God prevail:" and the reason given for it, as related by Porphyry, is, "that Plotinus had been peaceable, gracious, and vigilant; that he had perpetually elevated his spotless soul to God; that he had loved God with his whole heart; that he had disengaged himself, to the utmost of his abilities, from this wretched life; that, elevating himself with all the powers of his soul, and by the several gradations taught by Plato, towards that Supreme Being which fills the universe, he had been enlightened by him; had enjoyed the vision of him without the help or interposition of ideas; had, in short, been often united to him." This is the account of Porphyry, who tells us also, that he himself had once been favoured with the vision. To this account, however,

we need scarcely add, that little credit is due: it agrees pretty much with modern enthusiasm and the reveries of Behmenists. Plotinus had also his familiar spirit, as well as Socrates; but, according to Porphyry, it was not one of those called *demons*, but of the order of those who are called *gods*; so that he was under the protection of a genius superior to that of other men. The superiority of his genius puffed him up not a little: for when Amelius desired him to share in the sacrifices, which he used to offer up on solemn festivals, "It is their business (replied Plotinus) to come to me, not mine to go to them:" "which lofty answer (says Porphyry) no one could guess the reason of, or dared to ask."

Porphyry put the 54 books of Plotinus in order, and divided them into six enneasies. The greater part of them turn on the most high-flown ideas in metaphysics; and this philosopher seems, in certain points, not to differ much from Spinoza. He wrote two books to prove, that "all being is one and the same;" which is the very doctrine of Spinoza. He inquires, in another book, "Whether there are many souls, or only one?" His manner of composing partook of the singularity of his nature: he never read over his compositions after he had written them; he wrote a bad hand, and was not exact in his orthography: he stood in need, therefore, of a faithful friend to revise and correct his writings; and he chose Porphyry for this purpose before Amelius, who had, however, been his disciple 24 years, and was very much esteemed by him. Some have accused Plotinus of plagiarism, with regard to Numenius; a slander which Amelius refuted. Longinus was once much prejudiced against our great philosopher, and wrote against his Treatise of Ideas, and against Porphyry's answer in defence of that treatise. He afterwards conceived a high esteem for him; fought industriously for all his books; and, in order to have them very correct, desired Porphyry to lend him his copy; but at the same time wrote to him in the following manner: "I always observed to you, when we were together, when we were at a distance from one another, as well as when you lived at Tyre, that I did not comprehend many of the subjects treated of by Plotinus; but that I was extremely fond of his manner of writing, the variety of his knowledge, and the order and disposition of his questions, which are altogether philosophical." "This single passage (says Bayle) shows the exalted genius, the exquisite discernment, and judicious penetration of Longinus. It cannot be denied, that most subjects which this philosopher examines are incomprehensible; nevertheless, we discover in his works a very elevated, fruitful, and capacious genius, and a close way of reasoning. Had Longinus been an injudicious critic, had he not possessed an exalted and beautiful genius, he would not have been so sensible of Plotinus's obscurity: for no persons complain less of the obscurity of a book, than those whose thoughts are confused and understanding is shallow." Marcellus Ficinus, at the request of Cosmo de Medicis, made a Latin version of the works of Plotinus, with a summary and analysis of each book; which was printed at Basil, first by itself, in 1559, and afterwards with the Greek in 1580, folio. His life was written by Porphyry, the most illustrious of his disciples.

PLOTUS, or DARTER, in ornithology, a genus of birds

Plotinus
Plotus

birds belonging to the order palmipeds. The bill is long and sharp-pointed; the nostrils are merely a long slit placed near the base; the face and chin are bare of feathers; the neck is very long; and the legs are short. They have four toes webbed together. There are three species of this genus, and three varieties of the second of these.

1. The plotus anhinga, or white-bellied darter, is not quite so big as a mallard; but its length from the point of the bill to the end of the tail is 10 inches. The bill, which is three inches long, is straight and pointed: the colour is greyish, with a yellowish base: the irides are of a gold colour: the head is small: the neck long and slender: the upper part of the back and scapulars are of a dusky black colour; the middle of the feathers are dashed with white: the lower part of the back, &c. are of a fine black colour: the under parts from the breasts are silvery white: the smaller wing coverts, and those in the middle, are dusky black; the larger ones are spotted with white, and the outer ones are plain black: the tail feathers are 12 in number, broad, long, and glossy black: the legs and toes are of a yellowish grey. This species is an inhabitant of Brasil, and is exceedingly expert and cunning in catching fish. Like the corvorant, it builds nests on trees, and roosts in them at night. It is scarcely ever seen on the ground, being always on the highest branches of trees on the water, or such as grow in the moist savannas or river sides. When at rest, it generally sits with the neck drawn in between the shoulders like the heron. The flesh is in general very fat; but has an oily, rank, and disagreeable taste like that of a gull.

2. The anhinga of Cayenne, or black-bellied anhinga, is as large as a common duck, with a very long neck, and a long sharp-pointed straight bill. The upper part of the bill is of a pale blue, and the lower is reddish: the eyes are very piercing: the head, neck, and upper part of the breast are light brown: both sides of the head, and the upper part of the neck, are marked with a broad white line: the back, scapulars, and wing coverts, are marked with black and white stripes lengthwise in equal portions: the quill feathers, the belly, thighs, and tail, are of a deep black colour; the tail is very long and slender: the legs and feet are of a pale green colour; and the four toes, like those of the corvorant, are united by webs. This species is found in the islands of Ceylon and Java. They generally sit on the shrubs that hang over the water; and, when they shoot out their long slender necks, are often taken for serpents at first sight.

Mr Latham describes three varieties of this species, which are all equal in size to the common birds of the species. The first and the second variety, which last Mr Latham calls the black darter, inhabit Cayenne; and third, or rufous darter, inhabits Africa, particularly Senegal, where it is called *kandar*.

3. The Surinam darter is about 13 inches long, being about the size of a teal. The bill is of a pale colour, and about $1\frac{1}{2}$ inch in length: the irides are red: the crown of the head is black, and the feathers behind form a sort of crest: the neck, as in the other species, is long and slender: the cheeks are of a bright bay colour: from the corner of each eye there comes a line of white: the sides and back part of the neck are marked with longitudinal lines of black and white: the

wings are black, and the tail is dusky brown: it is also tipped with white and shaped like a wedge: the breast and belly are white: the legs short, but very strong, and of a pale dusky colour: the four toes are joined by a membrane, and barred with black. This species inhabits Surinam, frequenting the sides of rivers and creeks, where it feeds on small fish and insects, especially on flies, which it catches with great dexterity. When domesticated, which often happens, the inhabitants call it the *sun bird*. Authors have differed exceedingly concerning the genus to which this species belongs, since it is found to differ from the others in some pretty essential characters: it agrees, however, in so many, and those the most essential, as sufficiently to excuse those naturalists who class it with the plotus genus. See *Latham's Synopsis of Birds*, vol. iii. part 2. p. 627.

PLOUGH, in agriculture: A machine for turning up the soil by the action of cattle, contrived to save the time, labour, and expence, which, without this instrument, must have been employed in digging the ground, and fitting it for receiving all sorts of seed. See AGRICULTURE, n° 83—95.

Amidst all the varieties which can occur in the manner of ploughing the ground, arising from difference of soil, local habits, and other causes, there is still a sameness in the task which gives a certain uniformity to the chief parts of the instrument, and should therefore furnish principles for its construction. There is not, perhaps, any invention of man that more highly merits our utmost endeavours to bring it to perfection; but it has been too much neglected by those persons who study machines, and has been considered as a rude tool, unworthy of their attention. Any thing appears to them sufficient for the clumsy task of turning up the ground; and they cannot imagine that there can be any nicety in a business which is successfully performed by the ignorant peasant. Others acknowledge the value of the machine, and the difficulty of the subject; but they think that difficulty insuperable, because the operation is so complicated, and the resistances to be overcome so uncertain, or so little understood, that we cannot discover any unequivocal principle, and must look for improvement only from experience or chance.

But these opinions are ill founded. The difficulty is indeed great, and it is neither from the ignorant farmer nor the rude artist that we can expect improvement. It requires the serious consideration of the most accomplished mechanicians; but from him we may expect improvement. We have many data: we know pretty distinctly what preparation will fit the ground for being the proper receptacle for the seed, and for supporting and nourishing the plants; and though it is, perhaps, impossible to bring it into this state by the operation of any instrument of the plough kind, we know that some ploughs prodigiously excel others in reducing the stiff ground to that uniform crumbling state in which it can be left by the spade. The imperfections of their performance, or what yet remains to be done to bring the ground into this state, is distinctly understood. It seems, then, a determinate problem (to use the language of mathematicians), because the operation depends on the invariable laws of mechanical nature.

It will therefore be very proper, under this article, to ascertain, if possible, what a plough in general ought to be, by describing distinctly its task. This will surely

Plough.

The plough

An instrument of the greatest value,

And may be improved.

The task it performs

Plough.

ly point out a general form, the chief features of which must be found under every variety that can arise from particular circumstances.

The plough performs its task, not by digging, but by being pulled along. We do not aim at immediately reducing the ground to that friable and uniform state into which we can bring it by the spade; but we wish to bring it into such a state that the ordinary operations of the season will complete the task.

For this purpose, a slice or sod must be cut off from the firm land. This must be shoved to one side, that the plough and the ploughman may proceed in their labour; and the sod must be turned over, so that the grass and stubble may be buried and rot, and that fresh soil may be brought to the surface; and all must be left in such a loose and open condition, that it may quickly crumble down by the influence of the weather, without baking into lumps, or retaining water. The first office is performed by the coulter, which makes a perpendicular cut in the ground. The point of the sock follows this, and its edge gets under the sod, and lifts it up. While lifting it up, it also heels it over, away from the firm land. The mould-board comes last, and pushes it aside, and gradually turns it over as far as is required.

The general form of the body of a plough is that of a wedge, or very blunt chisel, AFEDBC, (fig. 1.), having the lower corner D of its edge considerably more advanced than the upper corner B; the edge BD and the whole back AFDB is in the same perpendicular plane; the bottom FDB approaches to a triangular form, acute at D, and square at F; the surface BCED is of a complicated shape, generally hollow, because the angle ABC is always greater than FDE: this consequence will be easily seen by the mathematician. The back is usually called the LAND SIDE by the ploughmen, and the base FDE is called the SOLE, and FE the HEEL, and BCED the mould-board. Lastly, the angle AFE is generally square, or a right angle, so that the sole has level both as to length and breadth.

By comparing this form with attention, the reader will perceive that if this wedge is pulled or pushed along in the direction FD, keeping the edge BD always in the perpendicular cut which has been previously made by the coulter, the point D will both raise the earth and shove it to one side and twist it over; and, when the point has advanced from F to D, the sod, which formerly rested on the triangle DFE, will be forced up along the surface BCED, the line DF rising into the position Df, and the line EF into the position Ef.—Had the bottom of this furrow been covered with a bit of cloth, this cloth would be lying on the mould-board, in the position DfE: the slice, thus deranged from its former situation, will have a shape something like that represented in fig. 2.

In as much as the wedge raises the earth, the earth presses down the wedge; and as the wedge pushes the earth to the right hand, the earth presses the wedge to the left; and in this manner the plough is strongly pressed, both to the bottom of the furrow by its sole, and also to the firm land by its back or land-side. In short, it is strongly squeezed into the angle formed along the line FD (fig. 1.) by the perpendicular plane *ab* DF and the horizontal plane FDE; and in this manner the furrow becomes a firm groove, directing the motion of the plough, and giving it a resisting support, by which it

can perform all parts of its task. We beg our readers to keep this circumstance constantly in mind. It evidently suggests a fundamental maxim in the construction, namely, to make the land-side of the plough an exact plane, and to make the sole, if not plane, at least straight from point to heel. Any projection would tear up the supporting planes, destroy the directing groove, and expend force in doing mischief.

This wedge is seldom made of one piece. To give it the necessary width for removing the earth would require a huge block of timber. It is therefore usually framed of several pieces, which we shall only mention in order to have the language of the art. Fig. 3. represents the land-side of a plough, such as are made by James Small at Rosebank, near Forth, Mid Lothian. The base of it, CM, is a piece of hard wood, pointed before at C to receive a hollow shoeing of iron CO, called the SOCK, and tapering a little towards the hinder end, M, called the HEEL. This piece is called the HEAD of the plough. Into its fore part, just behind the sock, is mortised a sloping post, AL, called the SHEATH, the front of which is worked sharp, forming the edge of the wedge. Nearer the heel there is mortised another piece, PQ, sloping far back, called the STILT, serving for a handle to the ploughman. The upper end of the sheath is mortised into the long BEAM RH, which projects forward, almost horizontally, and is mortised behind into the stilt. To the fore end of the beam are the cattle attached. The whole of this side of the wedge is fashioned into one plain surface, and the intervals between the pieces are filled up with boards, and commonly covered with iron plates. The COULTER; WFE, is firmly fixed by its shank, W, into the beam, rakes forward at an angle of 45° with the horizon, and has its point E about six inches before the point of the sock. It is brought into the same vertical plane with the land-side of the plough, by giving it a knee outward immediately below the beam, and then kneeling it again downward. It is further supported on this side by an iron stay FH, which turns on a pin at F, passes through an eye-bolt I on the side of the beam, and has a nut screwed on it immediately above. When screwed to its proper slope, it is firmly wedged behind and before the shank.—Fig. 3. No 2. represents the same plough viewed from above. ST is the right hand or small stilt fixed to the inside of the mould-board LV.

Fig. 4. represents the bottom of the wedge. CM is the head, covered at the point by the sock. Just behind the sock there is mortised into the side of the head a smaller piece DE, called the wrest, making an angle of 16° with the land-side of the head, and its outside edge is in the same straight line with the side of the sock. From the point to the heel of the head is about 33 inches, and the extreme breadth of the heel is about nine. The side of the wedge, called the furrow side, is formed by the mould-board, which is either made of a block or plank of wood, or of a thick iron plate.

The sock drawn in this figure is called a SPEAR SOCK, and is chiefly used in coarse or stony ground, which requires great force to break it up. Another form of the sock is represented in the next figure 4. No 2. This is called a FEATHER SOCK, and has a cutting edge CF on its furrow side, extending back about ten inches, and to the right hand or furrow side about six. The

Plough

7
A fundamen-
tal maxim in
the construc-
tion of a
plough.

8
The several
parts of the
plough

9
Socks

Plate
cccxcviii.

5
General
form of
the plough.

6
Advantages
of this
form.

Plough. use of this is to cut the sod below, and detach it from the ground, as the coulter detaches it from the unploughed land. This is of great use when the ground is bound together by knotted roots, but it is evident that it cannot be used to advantage in very stony ground. In general, the feather sock is only fit for ground which has been under tolerable culture; but it greatly facilitates the labour of separating the sod. It may reasonably be asked, why the feather is not much broader, so as to cut the whole breadth of the furrow? This is sometimes done. But we must recollect that the sod is not only to be pushed aside, but also to be turned over. If it were completely detached by the feather, and chanced at any time to break on the back of the sock, it would only be pushed aside; but by leaving a little of the sod uncut, it is held fast below while it is shoved aside above, which cannot fail to twist it round. As the wreat advances, it easily destroys the remaining connection, which in general is very slight and crumbling.

Pro or breadth of the sole. The breadth of the sole at the heel determines the width of the furrow. Nine inches will give enough of room for a horse or man to walk in. A greater breadth is of no use, and it expends force in pushing the earth aside. It is a mistake to suppose that a broad sole gives more room for the turned slice to stand on; for whatever is the breadth of the furrow, the successive slices will be left at their former distances, because each is shoved aside to the same distance. When the breadth of a slice exceeds its depth, and it is turned on its side, it will now stand on a narrow base, but higher than before, and therefore will stand looser, which the farmers desire. But in this case it generally falls on its back before it has been far enough removed, and is then pushed aside, and left with the grassy side down, which is not approved of. On the other hand, when the depth considerably exceeds the breadth, the sods, now turned on their sides, must be squeezed home to the ploughed land, which breaks them and tosses them up, making rough work. In wet clay soil, this is also apt to knead them together. On the whole, it is best to have the breadth and depth nearly equal. But all this is workmanship, and has no dependence on the width of the sole behind.

It should be level. We have already said that the sole is generally level from right to left at the heel. This was not the case formerly, but the wreat was considerably raised behind. It resulted from this form, that the furrow was always shallower on the right side, or there was left a low ridge of unstirred earth between the furrows. This circumstance alone was a bad practice; for one great aim of ploughing is the renewal of the superficial soil. In this way of ribbing the furrows, the sod tumbles over as soon as it is pushed to the top of the rib on the right of the rut made by the plough; the firmest parts of it fall undermost, and the rest crumbles above it, making the work appear neat; whereas it is extremely unequal, and what most needs the influence of the weather to crumble it down is sheltered from it. Add to these circumstances, that the hollow is a receptacle for water, with a surface which can retain it, having been consolidated

by the pressure of the plough. For all these reasons, therefore, it seems advisable to form the furrow with a flat or level bottom, and therefore to keep the heel of the wreat as low as the heel of the head. For the same reason it is proper to hold the plough with the land-side perpendicular, and not to heel it over to that side, as is frequently done, producing the same ribbed furrow as an ill-formed sole.

There is great variety of opinions about the length of the plough. If considered merely as a pointed instrument, or even as a cutting instrument acting obliquely on a given length of sod, there can be no doubt but that it will be more powerful as it is longer; that is, it will require less force to pull it through the ground. But it must also shove the earth aside, and if we double its length we cause it to act on twice as much earth at once; for when the plough has entered as far as the heel, the whole furrow side is acting together in pushing the earth to the side. Now it is found, that the force necessary for pushing a mass of earth horizontally along the rough ground is nearly equal to its weight. It would seem, therefore, that nothing is to be gained by making the base of the plough of a great length, except a greater facility in making the first penetration, and this is chiefly performed by the coulter and sock; and a great length renders the plough heavy and cumbersome; and, by causing it to act long on the sod, tends to knead and cake it.

Nothing very precise can be offered on this subject. Some sensible advantage is derived by making the plough taper, especially forward, where it acts as a boring and cutting instrument; and for this purpose it is convenient to give the coulter a slope of 45 degrees. (This has also the advantage of throwing up the stones and roots, which it would otherwise drive before it through the firm ground.) And for the same reason the edge of the feather has a great slope, it being ten inches long and only six inches broad. But if we pursue this advantage too far we expose ourselves to another risk. It is sometimes necessary to heel over the plough to the right in order to get over some obstruction. In doing this, the coulter is necessarily raised for a moment, and the slanting cut now made by the feather becomes the directing groove for the plough. When the feather has a very long slope, this groove has force enough to guide the whole plough; and it is almost impossible for the ploughman to prevent it from running out of the ground to the land-side (A). The feather, therefore, should not exceed 10 or 12 inches in length.

But to return to the length of the plough, from which this observation has diverted us a little, we must add, that a long plough has a great advantage in the steadiness of its motion, having a much more extensive support both on the land-side and below, and being therefore less affected by its inequalities. Accordingly they are now made considerably longer than formerly; and 33 inches has been assumed as a proportion to 9 inches of breadth, in conformity to the most approved ploughs now in use.

We come now to treat of the mould-board. This The mould-board is board

(A) This is often felt with the excellent plough described by Mr Arbuthnot of Surry, in the Transactions of the Society for the Encouragement of Arts, &c. London.

Plough. is the most delicate part of the plough, and is to be seen in the greatest variety in the works of different artists, each of whom has a nostrum of great value in his own opinion. It is here indeed that the chief resistances are exerted and must be overcome; and a judicious form of this part of the plough may diminish them considerably, while it performs the work in the best manner. Without pretending to say that the different resistances are susceptible of an accurate determination, we can still draw sufficient information from palpable rules of mechanics to direct us to what would be nearly the best possible form for a mould-board. The task to be performed is to raise, push aside, and turn over to a certain degree, a slice already cut off from the firm ground. As we cannot provide for every inequality of the cohesion or tenacity of the earth, our safest way is to consider it as uniform: the weight of it is always so. As we cannot provide for every proportion between the tenacity and the weight, we must take an average or medium proportion which is not far from that of equality. Conceiving the slice at first as only tenacious, and without weight, it is an easy problem to determine the form which shall give it the intended twist and removal with the smallest force. In like manner we can proceed with a slice that has weight without tenacity. It is equally easy to combine both in any proportion; and it is easiest of all to make this combination on the supposition of equality of weight and cohesion. Supposing the slice like a brick, we know that it requires the greatest force to begin to raise it on one edge, and that the strain becomes less as it rises, till its centre of gravity is perpendicularly above the supporting angle. It requires no force to raise it further; for on pushing it beyond this position, it would fall over of itself, unless withheld by the tenacity of what is not yet raised. But on considering the form or plan of the sock, we find that while the weight of the sod resists most strongly, there is less of it in this situation actually rising, and this nearly in the same proportion with the labour of raising it; and we see that after the sod has attained that position in which it is ready to fall over, it has reached the wider part of the wrest, and is now pushed aside, which requires nearly the same force as to raise it: and this continues to the end of the operation.

When we take all these circumstances into consideration, it appears probable, that the compound resistance does not change much from first to last. If this be really the case, it is an undoubted maxim that the whole operation should proceed equally: if it does not, there must be some part of the sod that makes a resistance greater than the medium; and as the resistances in all this class of motions increase nearly as the squares of the velocities with which they are overcome, it is demonstrable that we shall lose power if we render them unequal.

15
How to be
formed.

Hence we deduce this maxim, *That as the plough advances through equal spaces, the twist and the lateral sliding of the sod should increase by equal degrees.* And this determines *a priori* the form of the mould-board. This principle occurred to Mr James Small a ploughmaker in Berwickshire, and he published a treatise on the subject in 1784. He has given several methods for constructing mould-boards, which he supposes are in conformity to his principle; but being merely a country artist, and unacquainted with science, his rules do not

produce mouldboards having this property of equable operation, altho' they do not deviate far from it. His book is a very useful and instructive performance, and level to the capacity of those for whom it is intended; and we have here availed ourselves of the author's information on many points.

The high character which Small's ploughs have maintained for 25 years is a strong argument for the truth of the maxim. We shall therefore give such instructions as will enable any intelligent workman to construct such a mould-board without any risk of failure; and if future theory or experience should discover any error in the principles from which this maxim is deduced, by showing that either the weight, the tenacity, or the lateral resistance, is exerted according to a different law from what has been assumed, the directions to be given are of such a nature that they adapt themselves with precision to these changes of principle, and will still produce a perfect and efficacious plough. Our readers will readily acknowledge that this is gaining a great point; because at present the instrument is constructed very much at random, and by a guess of the eye.

Let us now return to the wedge formerly made use of for illustrating the action of the plough. Suppose it placed in a furrow already ploughed, and that the space before the line FE (fig. 1.), which is square from the line of motion FD, is covered with a piece of cloth or carpet, and that the point of the wedge enters upon it at F, and advances to D. It will evidently raise the cloth, which will now cover the side of the wedge, forming the triangle FDE. The line FD is what formerly lay in the angle along the line FD, and FE formerly lay on FE. It is this line FE therefore that we are to raise, shove aside, and twist round, by equal degrees, while the plough advances through equal spaces.

Now, if the length DF of the plough-wedge, reckoned from the point of the sock to the heel, be 33 inches, and the breadth FE behind be 9 inches, the angle DEF or DEF will be nearly 74° . The construction of the furrow side of the plough is therefore reduced to this very simple problem, "To make the angle DEF turn equably round the axis DE, while the angular point E advances equably from D to E."

This will be done by means of the following very simple tool or instrument. Let IHFK (fig. 5.) be a piece of hard wood, such as oak, a foot long, three inches broad, and an inch thick. Plant on this another piece BHFC of the same breadth, four inches long, and half an inch thick. This will leave beyond it a flat 8 inches long. We shall call this the *stock* of the instrument. Let ABC be a piece of clean oak half an inch thick, 20 inches long, and three inches broad at the end BC. Let this be fashioned like the stile of a sun-dial, having its angle ABC 74° . Let it have a part BCE square, to the extent of four inches from C, and the rest EA worked into the form of a straight slender rod. Let EFG be a semicircle of clean plane-tree or of metal four inches radius: fasten this by small screws to the square part of the stile CE, so that its centre may be at C. Let this semicircle be divided into 180 degrees, and numbered from G along the arch GFE, so that 0° may be at G, and 180° at E. Let this stile and semicircle turn round the line BC by means of small hinges. This instrument may be called the mould-board, gage, or protractor. When the stile is folded down on the stock

stock BIK, the point G will be at F; and when it is raised up to any angle, the degrees will be pointed out on the femicircle by the straight edge CF.

Nothing can be more obvious than the manner of employing this instrument once we have determined the most proper position for the sod when the work is completed. Now it seems to be the opinion of the most intelligent farmers, that the best position of the sod is that represented in fig 6.

Fig. 6. represents a section of the ground and the working parts of the plough, as viewed by a person standing straight before it. ABDC is the unploughed ground, and WB the coulter, kneed in Small's manner. FGKB is the section of the plough (or rather of the whole space through which the plough has passed, for no part of the plough has this section). HOFE is the section of a slice, pushed aside and turned over, so as to lean on the next. HE is that side of the slice which formerly lay on KB. EF is the side cut off by the coulter; and FO is the upper or grassy side. The lower corners are supposed to be a little bruised inwards, as must generally happen.

The sod is pushed 9 inches to the right hand, and it leans with its grassy side on the preceding furrow, in an angle of about 50 degrees. In this position the grass is turned down so as to rot; and there is a hollow left below to allow the rain water to run freely off, and to receive the earth as it crumbles down by the weather: and if the harrow is dragged across these ridges, it distributes along the surface the mould which was formerly at the bottom. The sod has got a twist of 130 degrees: but it is evident, that after it has been turned 50 degrees, or even a little before this, it is ready to fall over of itself. It is sufficient therefore that it be turned 90 degrees when the heel of the wrest has reached it, and the remainder of the twist is given to it by the wing or flap of the mould-board. This, then, dictates to us the manner of applying the instrument.

Divide the edge DE (fig. 7.) of the wrest, or of a lath nailed on it, into 90 equal parts, and continue the divisions backwards to G in the same line to 130. Number the divisions backwards from the point of the sock; then place the protractor on the edge of the wrest, with the point B of fig. 5. at the 90th division (fig. 7.); that is, just at the heel, with the stock under the wrest, and the stile raised to 90°, and press it home to the joint, so that the stock may be square to the edge, and then the stile will be in the position suiting that part of the mould-board. In like manner slide the stock forward to the 80th division, and lower the stile to 80°, and it will have the position which suits that part of the mould-board. In the same way slide it forward to 70, 60, 50, &c. and lower the stile to 70°, 60°, 50°, &c. and we shall have the position for these several parts of the mould-board; and thus it may be formed to the very point of the sock, because the straight edge of the wrest may be continued so far. A block of wood may be hewed to fit these several positions of the protractor stile; and this, when placed with its straight edge on the outer line of the wrest, and cut away behind in the land-side plane, will be the exact shape of the plough-wedge. It would rise up indeed into a tall piece of singular shape, gradually tapering down to the point of the sock; but when cut off parallel to the ground, at the height of about 12 inches, it will form the mould-

board, the front or edge of the sheath, and the whole back of the sock except the feather, which is an extraneous piece. The wing or flap of the mould-board is formed in the same manner, by sliding the stock of the protractor to 100, 110, 120, 130, and opening the stile to 100°, 110°, 120°, 130°. This will extend the top of the mould-board to about 22 or 23 inches; but the lower part of the wing must be cut away, because it would push the sod too far aside after it has got the proper twist. The form of this part should be such as would exactly apply itself to a plank set at the head of the wrest, parallel to the land-side of the head, and leaning outward 40 degrees. This will be very nearly the case if it be made a sweep similar to the edge of the sheath. Fig. 8. is a resemblance of the surface of the mould-board; AD being the edge of the sheath, E the heel of the wrest, and EBC the wing or flap. When cut through in a perpendicular direction, the section is hollow; if cut horizontally it is convex; and if in the direction CE, making an angle of 74° with ED, it is straight. If the protractor be set on it at D, and gradually slid backwards, the mould-board will gradually open the stile, and the stile will skim its whole surface without any vacuity between them.

This form is given to the mould-board on the authority of the supposition that the sum of the resistances arising from weight and tenacity remains pretty constant in its whole length. This cannot be affirmed with confidence in any case, and is by no means true in all. In stiff clay soils the effects of tenacity prevail, and in light or crumbling soils the weight is the chief resistance. The advantage of this mode of construction is, that it can be adapted to any soil. If the difficulty of cutting and raising the sod is much greater than that of shoving it aside and turning it over, we have only to make the rise and twist more gentle towards the point of the sock, and more rapid as we advance; and it is easy to do this according to any law of acceleration that we please. Thus, instead of dividing the edge of the wrest DE (fig. 9.) continued to G into 130 parts, draw a line Gg perpendicular to it, and draw some curve line Dg convex toward DG, and divide this into equal parts in the points 10, 20, 30, 40, &c.; and then draw perpendiculars to the wrest edge, cutting it in 10, 20, 30, 40, &c. and apply the protractor to these points. It is evident that the divisions of the wrest line are bigger at D, and grow gradually less towards G; and therefore, because each has 10° more twist than the preceding, the twist will be more rapid as it approaches the end of the mould-board. This curve may be chosen so as to produce any law of acceleration. On the contrary, we produce a retarded or diminished twist by making the curve concave towards DG, as represented by the dotted curve.

The mathematical reader will observe, that this construction aims at regulating the twist round the line of the wrest ED. This does not produce precisely the same regulation round the line FD, which is the line of the plough's motion, and of the sod's position before it is ploughed over. The difference, however, is not worth attending to in a matter so little susceptible of precision. But the twist round the line FD may be regulated according to any law by this instrument with equal facility. Instead of placing the stock of the protractor square with the edge of the wrest, it may be placed

Plough.

square with the land-side of the plough. To do this, draw a line BL (fig. 5. n° 2.) across the stock from the point B, making the angle LBC 16° , and put a brass pin at L, making a hole in the stile that it may not be prevented from folding down. Then in using the instrument let the points B and L rest against the edge of the wrest, and proceed as directed.

A still greater variety of forms, and accommodation to particular views, with the same general dependence on principle, will be procured by giving the rod BA a motion round B in the plane of the stile, so as to form a stile of a variable angle.

A tool may even be constructed in which the rod BA might be a cutting knife: and the whole may be led along by a screw, while this knife turns round according to any law, and would gradually pare away the mould-board to the proper form.

Thus have we reduced the fashioning the operative part of the plough to a rule which is certain. We do not mean by this, that a mould-board made according to the maxim now given will make the best possible plough; but we have given a rule by which this part of the plough can be made unequivocally of a certain quality by every workman, whatever this quality may be, and this without being obliged to copy. No description of any curve mould-board to be met with in books has this advantage; and we say that this rule is capable of any systematic variation, either with respect to the width of furrow, or the quantity or variation of its twist. We have therefore put it in the power of any intelligent person to make such gradual and progressive changes as may serve to bring this most useful of all instruments to perfection. The angle of the head and wrest, and the curve for dividing the wrest line, can always be expressed in writing, and the improvements communicated to the public at large.

19
Mode of
the
plough's
action.

After this description of the working parts of a plough, and directions for giving it the most effective form, it will not be improper to consider a little its mode of action, with the view of attaining a more distinct conception of what is done by the ploughman and the cattle, and to direct him in his procedure.

Returning again to the wedge (fig. 1.), we see that it is pressed down at the point D, and as far back along the mould-board as its surface continues to look upward, that is, all the way to the heel of the wrest. Behind this, the perpendicular sections of the mould-board overhang, and look downward; and here, while pressing down the sod, the plough is pressed upwards. These two pressures tend to twist the plough round a transverse line somewhere between the heel and the point. The plough therefore tends to rise at the heel, and to run its point deeper into the ground. Upon the whole, the pressure downwards is much greater than the upward pressure. It is exerted over a much greater space, and is greater in most parts of that space. Behind, very little downward pressure is necessary, the sod being ready to fall down of itself, and only requiring a gentle touch to lay it in a proper position.

In like manner the plough is pressed backward by the resistance made to the coulter and sock, and part of the resistance made to the sloping side of the mould-board: and it is pressed to the left by the other part of the pressure on the sock and mould-board.

All these pressures must be balanced by the joint action of the cattle, the resistance of the bottom, and the resistance of the firm ground on the left hand or land-side.

It is the action of the cattle, exerted on that point to which they are attached, which produces all these pressures. It is demonstrated by the principles of mechanics, that this force must not only be equal to the mean or compound force of these resisting pressures, but must also be in the opposite direction.

It is further demonstrated, that if a body be dragged through any resisting substance by a force acting on any point G, and in any direction whatever GH, and really moves uniformly in that direction, the force exerted exactly balances the resistances which it excites, both as to quantity and direction: And if the body advances without turning round the point by which it is dragged, the resistances on one side of this point are in equilibrium with those on the opposite side.

And, lastly, it is demonstrated, that when this equilibrium is obtained, it is indifferent to what point in the line GH the force is applied. Therefore, in fig. 3. n° 1. the force acting in the direction HO may either be applied to the point of the beam H, or to the point N of the coulter, or to the point O of the sock.

When therefore a plough advances steadily, requiring no effort of the ploughman to direct it, if the line of draught OM (fig. 10.) be produced backwards to the point G of the mould-board, that point is the place round which all the resistances balance each other. This point may be called the *centre of resistance* and the *centre of action*.

It would be of importance to determine this point by principle; but this can hardly be done with precision even in a plough of a known form: and it is impossible to do it in general for all ploughs, because it is different in each. It even varies in any plough by every variation of the proportion between the weight and the cohesion of the sod. We see how it can be found experimentally in any given uniform sod, viz. by producing backwards the line of draught. Then, if the draught-rope, instead of being fixed to the muzzle of the beam, were fixed to this point, and if it were pulled in the same direction, the plough would continue to perform its work without any assistance from the ploughman, while the sod continued uniform. But the smallest inequality of sod would derange the plough so as to make it go entirely out of its path. Should the resistances between G and D prevail, the plough would go deeper, which would increase the resistances on that side where they already exceed, and the plough would run still deeper. Should the resistances behind G prevail, the heel would be pressed down, and the point would rise, which would still farther destroy the equilibrium, and, producing a greater deviation from the right path, would quickly throw the plough out of the ground.

For these reasons we must not think of attaching the draught to the centre of resistance; but must contrive a point of draught such as shall restore the plough to its proper position, when it has been driven out of it by any obstruction.

The muzzle or end of the beam is a point which will completely suit our purpose. For suppose that the resistance

istance on the back of the sock has prevailed, and the plough MNFD (fig. 10.) has taken the position *mnfd* represented by the dotted lines, the draught line GMO is brought down into the position *gmo*, diverging a little from GMO, and meeting the mould-board in a point *g* considerably before G. By this means the resistances on the hinder side of *g* are increased, and those before it are diminished, and the plough quickly regains its former position.

From these observations it is plain, that whatever is the situation of the centre of resistance, the point of draught may be so chosen that the action of the cattle shall be directly opposed to the resistance of the ground, and that moreover the plough shall have no tendency either to go deeper or to run out. This is the use of the apparatus at the point of the beam called the muzzle, represented at H (fig. 3.) It turns round a bolt *i* through the beam, and can be stopped at any height by another pin *k* put through the holes in the arch *lm*. A figure is given of the muzzle immediately below, as it appears when looking down on it. The eye to which the draught-rope is hooked is spread out horizontally, as shown by HK, and has several notches O in it, to either of which the hook can be applied. This serves to counteract any occasional tendency which the plough may have to the right or left.

When the plough goes on steadily, without any effort of the ploughman, it is said to be in trim, and to swim fair; the pressure before and behind the centre of action being in equilibrio with each other. In order to learn whether a plough will be in this manner under management, hook the draught-rope as high as possible. In this state the plough should have a continual tendency to rise at the heel, and even to run a little into the ground. Then hook the rope as low as possible. The plough should now press hard on the furrow with the heel, and have some tendency to run out of the ground. If both these are observed, the plough is properly constructed in this respect; if not, it must be altered, either by changing the position of the sock or that of the beam. Lowering the end of the beam will correct the tendency of the plough to go deeper; the raising the point of the sock will also have the same effect. But it is of considerable importance not to take the point of the sock out of the plane of the sod, and it is much better to make the alteration by the beam. The slope of the coulter has a considerable effect, but it cannot be placed very far from the inclination of 45° without the risk of choking the plough by driving the roots and stones before it. It is of great consequence to have the coulter sit exactly in the direction of the plough's motion: if it is in any other direction, it will powerfully twist the plough into its own track. As it must be fixed in the middle of the beam's thickness to have strength, it is removed a little from the plane of the land-side, and it was the usual practice to point it to the left below to compensate for this; but this by no means removes the disposition to twist, and it exposes to the risk of catching a stone between its point and that of the sock, which must now be driven forward through the firm ground at a great expence of labour to the cattle. Mr Small has very ingeniously remedied this by giving the coulter a short knee to the left immediately below the beam, and thus pointing it downwards in the plumb of the land-side. See fig. 6.

It is not without its use to know the absolute force necessary for tilling the ground. This has been frequently measured with a spring steel-yard. One of Small's ploughs, worked by two horses, and employed in breaking up stiff land which had been ploughed before winter, and much consolidated by the rains, required a force of 360 lbs. avoirdupois; and we may state this as the ordinary rate of such work; but moderately firm sod, under good culture, requires at a medium 320 lbs.

As we wish to embrace every opportunity of rendering this work useful to the public, we shall conclude this article with an account of a plough which has just now been recommended to public notice by the Scots Highland Society as extremely proper for a hilly country. The inventor, the Rev. Alexander Campbell minister at Kilcalmonell in Argyleshire, was honoured with the Society's gold medal, value L. 25.

A, the sock (fig. 11.); the land-side of which supplies the place of the coulter, and the sole of it serves for a feather; it is 18 inches long, and is made of a plate of iron 12 inches broad when finished, and somewhat under half an inch thick.—B, the head; to be made of iron in a triangular form, 4 inches broad by 2 inches at the thickest part. There are 5 inches of the head fixed in the sock.—C, the beam, 4 inches thick by 5 inches deep, gradually tapered thinner; the length 6 feet.—E, the sheath, must be of the same thickness with the beam above and the head below, and is five inches broad. An iron screw-bolt connects the beam and head behind the sheath.—F, the handles are so made that the slope of the mould-board, which is fixed to one of them, may be the longer and more gradual. They are 5 feet 8 inches long, and 2 feet 4 inches asunder at the ends.—G, the mould-board, consists of 7 rounded sticks 2 inches in diameter; the covert of them is in the plane of the sole, the rest in succession close to each other above it. This makes the mould-board 14 inches broad. To prevent any earth from getting over the mould-board, a thin dale 4 or 5 inches broad is fixed above it. The mould-board, land-side, and sole of the plough, are clad with iron.—The length is 20 inches: this added to 18 inches, the length of the sock, makes the length from point to heel 3 feet 2 inches.—The muzzle or bridle OPH is also of a more convenient and better construction than those commonly in use. By means of the screw-pins at L and M different degrees of land may be given to the plough; the iron rod LH being thereby moved sidewise in the socket LN, and up and down by OP. The rod is 30 inches long, one broad, and half an inch thick. It is hooked into a screw-bolt at H. Two inches of the rod project at N; in the form of an eye, before the muzzle, to receive the hook of the cross-tree.

The advantages of this plough are said to be: It is not so liable to be interrupted or turned out of its course by stones, roots, &c. as other ploughs are; nor does it dip so deep as to be liable to be broken by large stones or flags. The motion of the muzzle is also thought an improvement. Another advantage it has over other ploughs is, its not being so liable to be choked up by stubble, &c. This we understand to be its chief excellency, and an object much desired in the construction of the plough. Upon the whole, we are informed that this plough is lighter, less expensive, and less liable to

Plough,
Plough-
drill.

24
Objections
to its con-
struction.

go out of trim than the ordinary plough, and that with it two horses can plough land which require four with any other plough.

Such are said to be the advantages of this construction; but we cannot help expressing our apprehension that the uniting the coulter and feather at the point of the sock will expose the plough to great risks of being put out of order. When the upright edge strikes a stone obliquely, especially on the landside, it must be violently twisted round the point of the head; and, having but a moderate thickness at this part, may be broken or permanently twisted. The plough will then be continually running out of its direction: and we apprehend that this defect cannot be amended without taking off the sock and putting it in the fire. When a coulter is bent by the same cause, the ploughman can either rectify it by altering the wedging, or he can straighten it in the field; and it must be observed, that the plough opposes much less resistance to the derangement of this sort of coulter than of the common one. In the common coulter the strain does not so much tend to twist the plough round the line of its motion, as to press it wholly to landward. The resistance to this is great; but a very moderate force will twist it round its line of motion. In either case, if the blow be given in that point of the coulter where the draught line crosses it, there will be no twist of the whole plough, but the point of the plough will be forced horizontally to or from the lap. When the blow is out of this line, the strain tends to twist the beam or the plough. Experience will determine which of the two is the most hazardous. These ploughs are made by Thomas Lindsay, Abbeyhill, Edinburgh, and models are to be seen in the hall of the Highland Society.

Plough-drill. See *DRILL sowing*, and *AGRICULTURE*, p. 318; and Plate VII. and 2d Plate VII. In the Gentleman's Magazine for July 1793, p. 602, Mr Wickins of Pondhead Lodge, New Forest, gives an account of a simplified drill-plough-invented by himself. Its importance is increased, he thinks, by the cheapness and easy construction of it, because it can be used upon a small scale by a single man, and upon a larger scale by two men, or a man and boy; so that the inconvenience suffered by horses trampling the ground, &c. is hereby avoided. To the drill for sowing is occasionally annexed a blade for hoeing between the rows: "the good effects of which (says Mr Wickins) are no less obvious from its nurturing the growth of the corn, and producing collateral shoots from the application of fresh soil; but also from its affording the means of extirpating the weeds which are so obnoxious to it." He informs us likewise, that his single hand-drill hath been seen and approved by the Bath Society; and they have in consequence been pleased to vote him an honorary and corresponding member. Since that time, however, he says, he has very materially improved and simplified it. Mr Wickins's description of his invention is far from being accurate; and the drawing, of which there is an engraving in the same magazine, was taken when his machine was in its infant and less improved state. He promises, however, farther information in the Gentleman's Magazine, and he offers more particulars to such agricultural people as shall desire it. We are far from decidedly thinking that this plough-drill is a real improvement, or that it ever will come to be real-

ly and generally useful. We have seen so many of these Ploughs and such like improvements make a great noise for a while, and then fall into neglect, without having ever come into use, as makes us shy in forming opinions respecting the utility of those instruments which are so often and so boldly obtruded on the world as the *ne plus ultra* of improvements in their several spheres. We think it our duty, however, to give every attempt at improvement, especially in the useful arts, all the justice in our power; and, on this account, it has always been our custom to lay before our readers such claims to it as have occurred in the course of our work, whether those claims appeared to ourselves to be just or not.

PLOUGHMAN, the person who guides the plough in the operation of tilling.

PLOUGHING, in agriculture, the turning up the earth with a plough. See *AGRICULTURE*, Part II. *passim*.

PLOVER, in ornithology, a species of *CHARADRIUS*.

These birds usually fly in exceedingly large flocks in the places they frequent; people talk of 2,000 or 30,000 being seen in a flock. They generally come to us in September, and leave us about the end of March. In cold weather they are found very commonly on lands lying near the sea in quest of food; but in thaws and open seasons they go higher up in the country.

They love to feed on ploughed lands, but never remain long at a time on them, for they are very cleanly in their nature; and the dirt which lodges on their beaks and feet give them so much uneasiness, that they fly to the nearest water to wash themselves. When they roost, they do not go to trees or hedges; but sit squatting on the ground like ducks or geese, far from trees or hedges, when the weather is calm; but when it is stormy, they often get under shelter. In wet weather they do not sleep in the night at all, but run about picking up the worms as they crawl out of the ground; during this feeding they are continually making a small cry, that serves to keep them together; and in the morning they take flight. If in their flight they spy any others on the ground, they call them up; and if they refuse to come, the whole body descends to see what food there is in the place that detains them.

Plovers are very easily taken at the time of their first coming over, when they have not got any other birds mixed among them; but when they afterwards pick up the teal and other shy birds among them, it becomes more difficult. The best season for taking them is in October, especially in the beginning of that month: after this they grow timorous, and are not easily taken again till March, which is the time of their coupling. The severest frosts are not the best season for taking them in nest, but variable weather does better. The north-west wind is found disadvantageous to the taking of them; and in general, great regard is to be paid to the course of the wind in the setting of the nets. All sea-fowl fly against the wind when the land lies that way; and the nets for taking them are therefore to be placed in a proper direction accordingly.

PLOWDEN (Edmund), serjeant at law, was the son of Humphrey Plowden of Plowden in Shropshire, of an ancient and genteel family. He was first a student of the university of Cambridge, where he spent three years in the study of philosophy and medicine.

He

PLOUGH.

Plate CCCXCVIII.

Fig. 1.

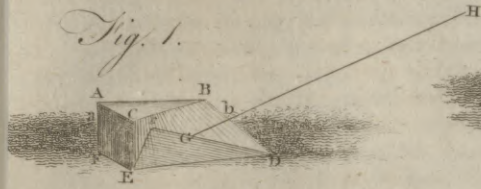


Fig. 2.

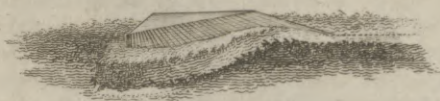


Fig. 4. No. 1.

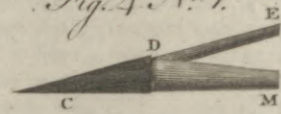


Fig. 4. No. 2.

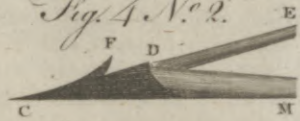


Fig. 3. No. 1.



Fig. 3. No. 2.



Scale of Feet for Smalls Plough.

Fig. 5. No. 1.

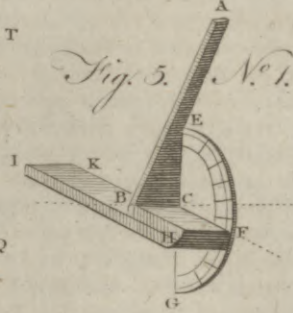


Fig. 5. No. 2.

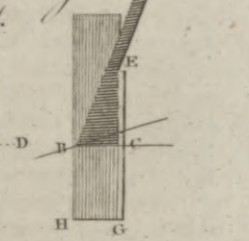


Fig. 8.

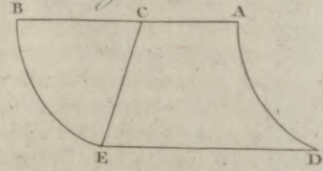


Fig. 7.

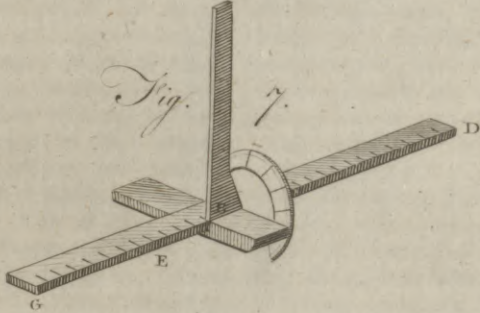


Fig. 6.

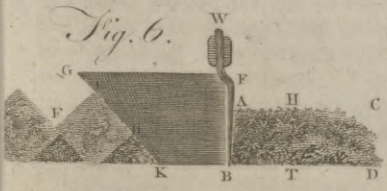


Fig. 9.

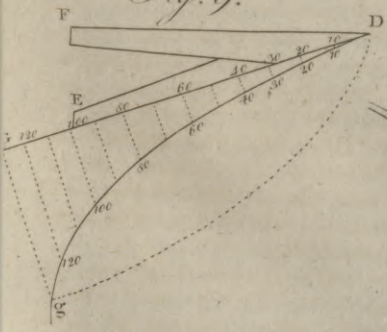
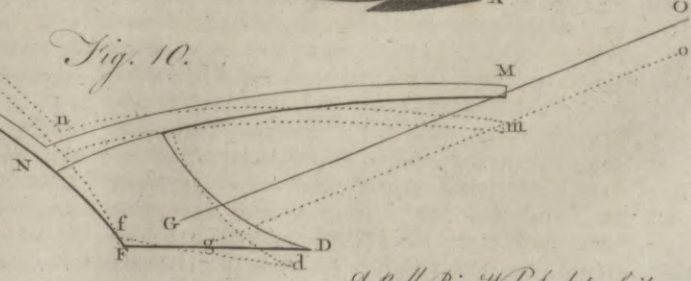


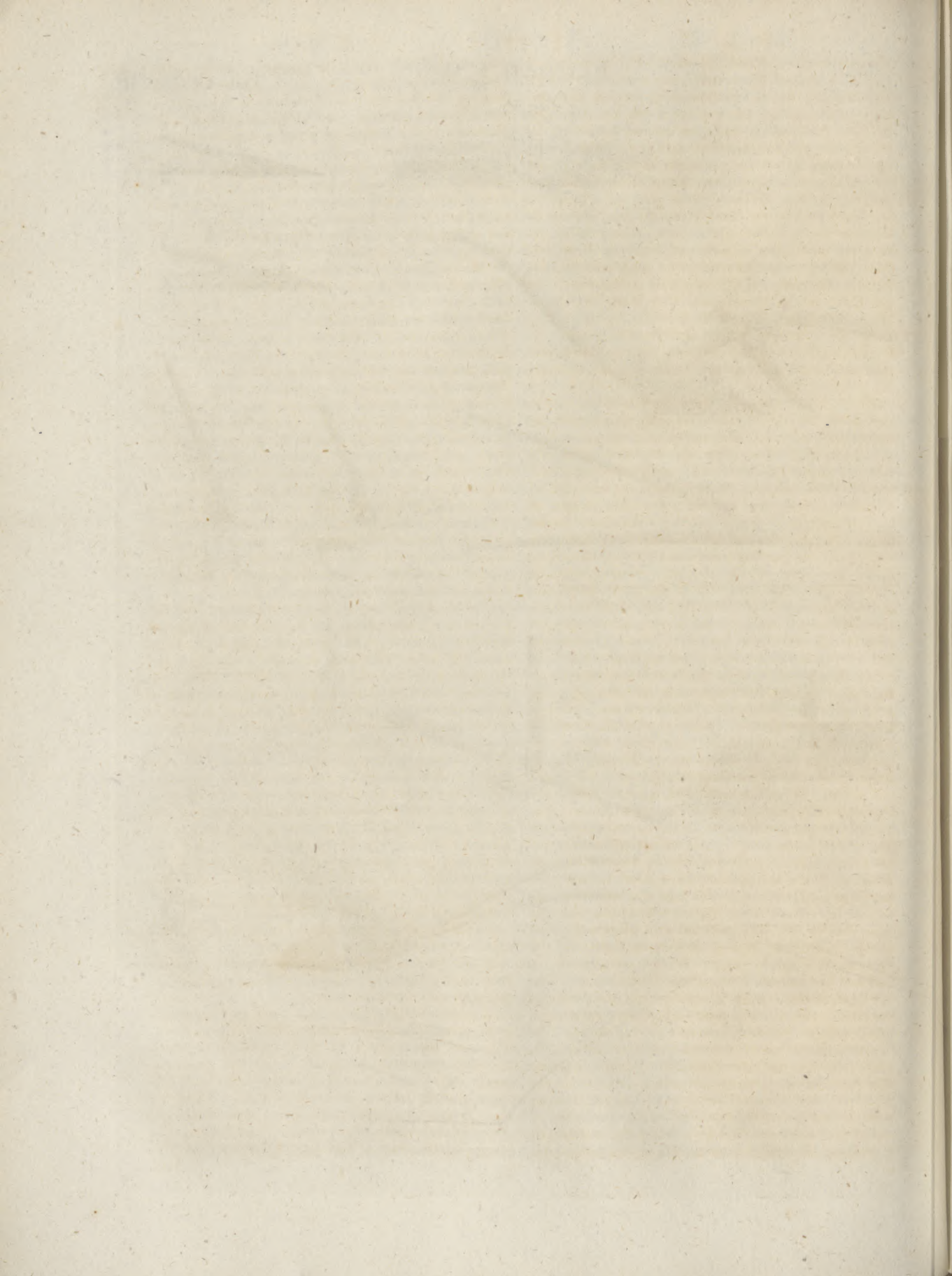
Fig. 11 The Argyleshire Plough.



Fig. 10.



A. Bell Prin. War. Sculptor fecit.



luche. He then removed to Oxford, where, having continued his former studies about four years more, in 1552 he was admitted to the practice of physic and surgery: but probably finding the practice of the art of healing less agreeable than the study, he entered himself of the Middle Temple, and began to read law. Wood says, that in 1557 he was summer reader to that society, and Lent-reader three years after, being then serjeant and oracle of the law. He died in the year 1584, aged 67; and was buried in the Temple-church, near the north-wall, at the east-end of the choir. He married the daughter of William Sheldon of Boley in Worcester-shire; by whom he had a son, who died soon after his father. He wrote, 1. Commentaries or Reports of divers Cases, &c. in the reigns of King Edw. VI. Queen Mary, and Queen Elizabeth; London, 1571, 78, 99, 1613, &c. Written in the old Norman language. 2. Queries, or a Moot-book of cases, &c. translated, methodized, and enlarged, by H. B. of Lincoln's-Inn; Lond. 1662, 8vo.

PLUCHE (Antony), born at Rheims in 1688, merited by his engaging manners and proficiency in the belles-lettres the appointment of humanist in the university of that city. Two years after he obtained the professor of rhetoric's chair, and was admitted into holy orders. The bishop of Laon (Clermont) informed of his talents, offered him the direction of the college of his episcopal city. By his industry and superior knowledge, a proper order and subordination soon took place in it; but some particular opinions respecting the affairs of the time disturbed his tranquillity, and obliged him to quit his office. The intendant of Rouen, at the request of the celebrated Rollin, entrusted him with the education of his son. Abbé Pluche having filled that place with success and great honour to himself, left Rouen and went to Paris, where, by the patronage of some literary friends and his own excellent writings, he acquired a very distinguished reputation for learning. He published, 1. *Le Spectacle de la Nature* (Nature Displayed), in 9 vols in 12mo. This work, which is equally instructive and entertaining, is written with perspicuity and elegance; but the form of dialogue which he adopted has drawn him into the fault of being rather too prolix. The speakers, who are the Prior, the Count, and Countess, are not distinguished by any striking feature; but they have all the common character, which is tolerably pleasing, not excepting even that of the little chevalier De Breuil, who is, however, a mere scholar. This is the opinion which Abbé Desfontaines has formed of this work. Though the author has given the conversations a pretty ingenious turn, and even some vivacity, yet they now and then fall into the tone of the college. 2. *Histoire du Ciel*, or History of the Heavens, in 2 vols in 12mo. In this performance we find two parts almost independent of one another. The first contains some learned inquiries into the origin of the poetic heavens. It is nearly a complete mythology, founded upon ideas which are new and ingenious. The second is the history of the opinions given by philosophers respecting the formation of the world. The author shows the inutility, the inconsistency, and uncertainty, of the most esteemed systems; and concludes with pointing out the excellence and sublime simplicity of the Mosaic account. Besides a noble and well-turned expression, we find in it an erudition which does not

fatigue the mind. As to the foundation of the system explained in the first part, though it appears extremely plausible, we will not take upon us to say how far it is true: Voltaire called it *Fable du Ciel*, or a Fable of the Heavens. 3. *De Linguarum artificio*; a work which he translated with this title, *La Mécanique des Langues*, in 12mo. In this treatise he proposes a short and easy method of learning languages, which is by the use of translations instead of themes or exercises; and we must admit his reflections on that subject are both judicious and well expressed. 4. Harmony of the Psalms and the Gospel, or a Translation of the Psalms and Hymns of the Church, with Notes relative to the Vulgate, the Septuagint, and Hebrew Text, printed at Paris in 1764, in 12mo. In 1749, Abbé Pluche retired to Varenne-St Maure, where he gave himself up entirely to devotion and study. Having become so deaf that he could not hear without the help of a trumpet, the capital afforded him very little entertainment. It was in this retreat that he died of an apoplexy on the 20th of November 1761, at the age of 73 years. He possessed those qualities which form the scholar, the honest man, and the Christian: temperate in his meals, true to his word, an affectionate parent, a sensible friend, and a humane philosopher; he gave lessons of virtue in his life as well as in his writings. His submission to all the dogmas of religion was very great. Some Deists having been surprised that, in matters of faith, he should think and speak like the vulgar, his answer was, "I glory in doing so: It is infinitely more rational to believe the word of God, than to follow the glimmering lights of a reason which is limited and subject to error."

PLUG, certain pieces of timber, formed like the frustum of a cone, and used to stop the hause-holes and the breaches made in the body of a ship by cannon-balls; the former of which are called *hause-plugs*, and the latter *shot plugs*, which are formed of various sizes in proportion to the holes made by the different sizes of shot, which may penetrate the ship's sides or bottom in battle; accordingly they are always ready for this purpose.

PLUKENET (Leonard), a physician who flourished in the reign of King Charles II. was one of the most excellent and laborious botanists of that or any other age. He was author of the *Phytographia Plucenetiana*, the *Almagestum Britannicum*, and other works of the like kind, on which he spent the greatest part of his life and fortune. His Phytography is mentioned with the highest encomiums in the Philosophical Transactions for February 1696-7. His *Opera Botannica*, with cuts, were printed at London in 6 vols folio, in 1720.

PLUM-TREE, in botany. See PRUNUS.

PLUMAGE, the feathers which serve birds for a covering. See ORNITHOLOGY, p. 506.

PLUMB-LINE, among artificers, denotes a perpendicular to the horizon; so called, as being commonly erected by means of a plummet.

PLUMBAGO, LEAD-WORT; a genus of the monogynia order, belonging to the pentandria class of plants. There are four species; the most remarkable of which are the Europæa and Zeylonica. The first grows naturally in the southern parts of Europe, and has a perennial root striking deep in the ground. There are many slender channelled stalks, about three feet high, terminated by tufts of small funnel-shaped flowers, of a blue or white colour. The second grows naturally in

Plumbago, both the Indies. The upper part of the stalk and em-
Plumbery palement are covered with a glutinous juice, which catches the small flies that light upon it. The former species is propagated by parting the roots, and by seeds; but the latter is too tender to thrive in the open air in this country.

PLUMBAGO. See *Black-LEAD*.

PLUMBERY, the art of casting and working lead, and using it in building.

As this metal melts soon and with little heat, it is easy to cast it into figures of any kind, by running it into moulds of brass, clay, plaster, &c. But the chief article in plumbery is sheets and pipes of lead; and as these make the basis of the plumber's work, we shall here give the process of making them.

In casting *sheet-lead*, a table or mould is made use of, which consists of large pieces of wood well jointed, and bound with bars of iron at the ends; on the sides of which runs a frame consisting of a ledge or border of wood, three inches thick and four inches high from the mould, called the *sharp*: The ordinary width of the mould, within these sharps, is from four to five feet; and its length is 16, 17, or 18 feet. This should be something longer than the sheets are intended to be, in order that the end where the metal runs off from the mould may be cut off, because it is commonly thin or uneven, or ragged at the end. It must stand very even or level in breadth, and something falling from the end in which the metal is poured in, viz. about an inch or an inch and a half in the length of 16 or 17 feet or more, according to the thinness of the sheets wanted; for the thinner the sheet, the more declivity the mould should have. At the upper end of the mould stands the pan, which is a concave triangular prism, composed of two planks nailed together at right angles, and two triangular pieces fitted in between them at the ends. The length of this pan is the whole breadth of the mould in which the sheets are cast; it stands with its bottom, which is a sharp edge, on a form at the end of the mould, leaning with one side against it; and on the opposite side is a handle to lift it up by, to pour out the melted lead; and on that side of the pan next the mould are two iron-hooks to take hold of the mould, and prevent the pan from slipping while the melted lead is pouring out of it into the mould. This pan is lined on the inside with moistened sand, to prevent it from being fired by the hot metal. The mould is also spread over, about two inches thick, with sand sifted and moistened, which is rendered perfectly level by moving over it a piece of wood called a *strike*, and smoothing it over with a smoothing plane, which is a plate of polished brass, about one-fourth of an inch thick and nine inches square, turned up on all the four edges, and with a handle fitted on to the upper or concave side. The sand being thus smoothed, it is fit for casting sheets of lead: but if they would cast a cistern, they measure out the bigness of the four sides; and having taken the dimensions of the front or fore-part, make mouldings by pressing long slips of wood, which contain the same mouldings, into the level sand; and form the figures of birds, beasts, &c. by pressing in the same manner leaden figures upon it, and then taking them off, and at the same time smoothing the surface where any of the sand is raised up by making these impressions upon it. The rest of the operation is the same in casting either cisterns

or plain sheets of lead. But before we proceed to mention the manner in which that is performed, it will be necessary to give a more particular description of the *strike*. The *strike*, then, is a piece of board about five inches broad, and something longer than the breadth of the mould on the inside; and at each end is cut a notch about two inches deep, so that when it is used it rides upon the sharps with those notches. Before they begin to cast, the *strike* is made ready by tacking on two pieces of an old hat on the notches, or by slipping a case of leather over each end, in order to raise the under side about one-eighth of an inch or something more above the sand, according as they would have the sheet to be in thickness; then they tallow the under edge of the *strike*, and lay it across the mould. The lead being melted, it is put into the pan with ladles, in which, when there is a sufficient quantity for the present purpose, the scum of the metal is swept off with a piece of board to the edge of the pan, letting it settle on the sand, which is by this means prevented from falling into the mould at the pouring out of the metal. When the lead is cool enough, which must be regulated according to the thickness of the sheets wanted, and is known by its beginning to stand with a shell or wall on the sand round the pan, two men take the pan by the handle, or else one of them lifts it by the bar and chain fixed to a beam in the ceiling, and pour it into the mould, while another man stands ready with the *strike*, and, as soon as they have done pouring in the metal, puts on the mould, sweeps the lead forward, and draws the overplus into a trough prepared to receive it. The sheets being thus cast, nothing remains but to roll them up or cut them into any measure wanted: but if it be a cistern, it is bent into four sides, so that the two ends may join the back, where they are foldered together; after which the bottom is foldered up.

The method of casting pipes without soldering. To make these pipes they have a kind of little mill, with arms or levers to turn it withal. The moulds are of brass, and consist of two pieces, which open and shut by means of hooks and hinges, their inward caliber or diameter being according to the size of the pipe, usually two feet and a half. In the middle is placed a core or round piece of brass or iron, somewhat longer than the mould, and of the thickness of the inward diameter of the pipe. This core is passed through two copper rundles, one at each end of the mould, which they serve to close; and to these is joined a little copper tube about two inches long, and of the thickness the leaden pipe is intended to be of. By means of these tubes, the core is retained in the middle of the cavity of the mould. The core being in the mould, with the rundles at its two ends, and the lead melted in the furnace, they take it up in a ladle, and pour it into the mould by a little aperture at one end, made in the form of a funnel. When the mould is full, they pass a hook into the end of the core, and, turning the mill, draw it out; and then opening the mould, take out the pipe. If they desire to have the pipe lengthened, they put one end of it in the lower end of the mould, and pass the end of the core into it; then shut the mould again, and apply its rundle and tube as before, the pipe just cast serving for a rundle, &c. at the other end. Things being thus replaced, they pour in fresh metal, and repeat the operation till they have got a pipe of the length required.

Plumbum
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Plumbing

For making pipes of sheet-lead, the plumbers have wooden cylinders, of the length and thickness required; and on these they form their pipes by wrapping the sheet around them, and soldering up the edges all along them.

The lead which lines the Chinese tea-boxes is reduced to a thinness which we are informed European plumbers cannot imitate. The following account of the process by which the plates are formed was communicated to a writer in the Gentleman's Magazine by an intelligent mate of an East Indian. The cafter sits by a pot containing the melted metal; and has two large stones, the under one fixed, the upper moveable, directly before him. He raises the upper stone by pressing his foot upon the side of it, and with an iron ladle pours into the opening a proper quantity of the fluid metal. He then immediately lets fall the upper stone, and by that means forms the lead into a thin irregular plate, which is afterwards cut into a proper shape. The surfaces of the stones, where they touch each other, are exactly ground together.

PLUMBUM, LEAD. See LEAD.

PLUMBUM Corneum, a combination of lead with the marine acid. See CHEMISTRY, n° 812.

PLUME, in botany, the bud or germ. See GEMMA.

PLUMIER (Charles), a learned Minim, born at Marseilles, and one of the most able botanists of the 17th century. He was instructed by the famous Maignan, who taught him mathematics, turnery, the art of making spectacles, burning-glasses, microscopes, and other works. He at length went to Rome to perfect himself in his studies, and there applied himself entirely to botany under a skilful Italian. At his return to Provence, he settled in the convent at Bornes, a maritime place near Hieres, where he had the convenience of making discoveries in the fields with respect to simples. He was some time after sent by the French king to America, to bring from thence such plants as might be of service in medicine. He made three different voyages to the Antilles, and stopped at the island of St Domingo. The king honoured him with a pension; and he at last settled at Paris. However, at the desire of M. Fagon, he prepared to go a fourth time to America, to examine the tree which produces the Jesuits bark; but died at the port of Santa Maria, near Cadiz, in 1706. He wrote several excellent works; the principal of which are, 1. A volume of the Plants in the American Islands. 2. A Treatise on the American Fern. 3. The Art of Turnery; a curious work embellished with plates.

PLUMMET, PLUMB-Rule, or *Plumb line*, an instrument used by carpenters, masons, &c. in order to judge whether walls, &c. be upright planes, horizontal, or the like. It is thus called from a piece of lead, fastened to the end of a chord, which usually constitutes this instrument. Sometimes the string descends along a wooden ruler, &c. raised perpendicularly on another; in which case it becomes a level.

PLUMMING, among miners, is the method of using a mine-dial, in order to know the exact place of the work where to sink down an air-shaft, or to bring an adit to the work, or to know which way the load inclines when any flexure happens in it.

It is performed in this manner: A skilful person with an assistant, and with pen, ink, and paper, and a long

line, and a sun-dial, after his guess of the place above ground, descends into the adit or work, and there fastens one end of the line to some fixed thing in it; then the incited needle is let to rest, and the exact point where it rests is marked with a pen: he then goes on farther in the line still fastened, and at the next flexure of the adit he makes a mark on the line by a knot or otherwise: and then letting down the dial again, he there likewise notes down that point at which the needle stands in this second position. In this manner he proceeds, from turning to turning, marking down the points, and marking the line, till he comes to the intended place: this done, he ascends and begins to work on the surface of the earth what he did in the adit, bringing the first knot in the line to such a place where the mark of the place of the needle will again answer its pointing, and continues this till he come to the desired place above ground, which is certain to be perpendicular over the part of the mine into which the air-shaft is to be sunk.

PLUMOSE, something formed in the manner of a feather, with a stem and fibres issuing from it on each side; such are the antennæ of certain moths, butterflies, &c.

PLURAL, in grammar, an epithet applied to that number of nouns and verbs which is used when we speak of more than one thing. See GRAMMAR.

PLURALITY, a discrete quantity, consisting of two or a greater number of the same kind: thus we say, a plurality of gods, &c. See the article ASTRONOMY, n° 157. for the arguments both for and against a plurality of worlds.

PLURALITY of Benefices, or *Livinges*, is where the same clerk is possessed of two or more spiritual preferments, with cure of souls. See BENEFICE.

The smallness of some benefices first gave rise to pluralities; for an ecclesiastic, unable to subsist on a single one, was allowed to hold two; and at length the number increased without bounds. A remedy was attempted for this abuse at the council of Lateran under Alexander III. and Innocent III. in the year 1215, when the holding more than one benefice was forbid by a canon under the penalty of deprivation; but the same canon granting the pope a power to dispense with it in favour of persons of distinguished merit, the prohibition became almost useless. They were also restrained by statute 21 Hen. VIII. cap. 13. which enacts, that if any person having one benefice with cure of souls, of the yearly value of 8 l. or above (in the king's books), accept any other with cure of souls, the first shall be adjudged in law to be void, &c. though the same statute provides for dispensation in certain cases.

In England, in order to procure a dispensation, the presentee must obtain of the bishop, in whose diocese the livings are, two certificates of the values in the king's books, and the reputed values and distance; one for the archbishop, and the other for the lord-chancellor. And if the livings lie in two dioceses, then two certificates of the same kind are to be obtained from each bishop. He must also show the archbishop his presentation to the second living; and bring with him two testimonials from the neighbouring clergy concerning his behaviour and conversation, one for the archbishop and the other for the lord-chancellor; and he must also show the archbishop his letters of orders, and a certificate of his hav-

Plumose
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Plurality.

Plus
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Plutarch.

ving taken the degree of master of arts at the least, in one of the universities of this realm, under the hand of the register. And if he be not doctor or bachelor of divinity, nor doctor nor bachelor of law, he is to procure a qualification of a chaplain, which is to be duly registered in the faculty office, in order to be tendered to the archbishop, according to the statute. And if he hath taken any of the aforesaid degrees, which the statute allows as qualifications, he is to procure a certificate thereof as already mentioned, and to show the same to the archbishop; after which his dispensation is made out at the faculty office, where he gives security according to the direction of the canon. He must then repair to the lord-chancellor for confirmation under the broad seal; and he must apply to the bishop of the diocese where the living lies for his admission and institution. By the several stamp-acts, for every skin, or paper, or parchment, &c. on which any dispensation to hold two ecclesiastical dignities or benefices, or a dignity and a benefice, shall be engrossed or written, there shall be paid a treble 40s. stamp duty.

We have also a regulation in regard to pluralities; but it is often dispensed with: for, by the faculty of dispensation, a pluralist is required, in that benefice from which he shall happen to be most absent, to preach 13 sermons every year, and to exercise hospitality for two months yearly.

In Germany the pope grants dispensations for possessing a plurality of benefices, on pretence that the ecclesiastical princes there need large revenues to bear up against the Protestant princes.

PLUS, in algebra, a character marked thus +, used for the sign of addition. See ALGEBRA, p. 400, and NEGATIVE Sine.

PLUSH, in commerce, &c. a kind of stuff, having a sort of velvet knap or shag on one side, composed regularly of a woof of a single woollen thread and a double warp; the one wool, of two threads twisted; the other goats or camels hair; though there are some plushes entirely of worsted, and others composed wholly of hair.

PLUTARCH, a great philosopher and historian of antiquity, who lived from the reign of Claudius to that of Hadrian, was born at Chæronea, a small city of Bœotia in Greece. Plutarch's family was ancient in Chæronea: his grandfather Lamprias was eminent for his learning and a philosopher; and is often mentioned by Plutarch in his writings, as is also his father. Plutarch was initiated early in study, to which he was naturally inclined; and was placed under the care of Ammonius, an Egyptian, who, having taught philosophy with great reputation at Alexandria, from thence travelled into Greece, and settled at Athens. Under this master he made great advances in knowledge; and like a thorough philosopher, more apt to regard things than words, he pursued this knowledge to the neglect of languages. The Roman language at that time was not only the language of Rome, but of Greece also: and much more used there than the French is now in England. Yet he was so far from regarding it then, that, as we learn from himself, he became not conversant in it till the declension of his life: and, though he is supposed to have resided in Rome near 40 years at different times, yet he never seems to have acquired a competent skill in it. But this was not the worst: he did not culti-

vate his mother-tongue with any great exactness; and hence that harshness, inequality, and obscurity in his style, which has so frequently and so justly been complained of.

After he was principled and grounded by Ammonius, having an insatiable thirst for knowledge, he resolved to travel. Egypt was at that time, as formerly it had been, famous for learning; and probably the mysteriousness of their doctrine might tempt him, as it had tempted Pythagoras and others, to go and converse with the priesthood of that country. This appears to have been particularly his business, by his treatise *Of Isis and Osiris*: in which he shows himself versed in the ancient theology and philosophy of the wife men. From Egypt he returned into Greece; and visiting in his way all the academies and schools of the philosophers, gathered from them many of those observations with which he has abundantly enriched posterity. He does not seem to have been attached to any particular sect, but culled from each of them whatever he thought excellent and worthy to be regarded. He could not bear the paradoxes of the Stoics, but yet was more averse from the impiety of the Epicureans: in many things he followed Aristotle; but his favourites were Socrates and Plato, whose memory he revered so highly, that he annually celebrated their birth-days with much solemnity. Besides this, he applied himself with extreme diligence to collect not only all books that were excellent in their kind, but also all the sayings and observations of wise men which he had heard in conversation or had received from others by tradition; and likewise to consult the records and public instruments preserved in cities which he had visited in his travels. He took a particular journey to Sparta, to search the archives of that famous commonwealth, to understand thoroughly the model of their ancient government, the history of their legislators, their kings, and their ephori; and digested all their memorable deeds and sayings with much care. He took the same methods with regard to many other commonwealths; and thus was enabled to leave us in his works such a rich cabinet of observation upon men and manners, as, in the opinion of Montaigne and Bayle, have rendered him the most valuable author of antiquity.

The circumstances of Plutarch's life are not known, and therefore cannot be related with any exactness. According to the learned Fabricius, he was born under Claudius, 50 years after the Christian era. He was married to a most amiable woman of his own native town, whose name, according to the probable conjecture of Rualdus, was Timoxena, and to whose sense and virtue he has borne the most affectionate testimony in his moral works. He had several children, and among them two sons; one called *Plutarch* after himself, the other *Lamprias* in memory of his grandfather. Lamprias was he, of all his children, who seems to have inherited his father's philosophy; and to him we owe the table or catalogue of Plutarch's writings, and perhaps also his apophthegms. He had a nephew, Sextus Chæroneus, who taught the learned emperor Marcus Aurelius the Greek tongue, and was much honoured by him. Some think, that the critic Longinus was of his family; and Apuleius, in the first book of his *Metamorphoses*, affirms himself to be descended from him.

On what occasion, and at what time of his life, he went

Plutarch.

Plutarch went to Rome, how long he lived there, and when he finally returned to his own country, are all uncertain. It is probable, that the fame of him went thither before him, not only because he had published several of his works, but because immediately upon his arrival, as there is reason to believe, he had a great resort of the Roman nobility to hear him: for he tells us himself, that he was so taken up in giving lectures of philosophy to the great men of Rome, that he had not time to make himself master of the Latin tongue, which is one of the first things that would naturally have engaged his attention. It appears that he was several times at Rome; and perhaps one motive to his inhabiting there was the intimacy he had contracted in some of these journeys with Sossius Senecio; a great and worthy man, who had been four times consul, and to whom Plutarch has dedicated many of his lives. But the great inducement which carried him first to Rome, was undoubtedly that which had carried him into so many other parts of the world; namely, to make observations upon men and manners, and to collect materials for writing the lives of the Roman worthies, in the same manner as he had already written those of the Grecian: and accordingly he not only conversed with all the living, but searched the records of the Capitol, and of all the libraries. Not but, as we learn from Suidas, he was intrusted also with the management of public affairs in the empire, during his residence in the metropolis. "Plutarch (says he) lived in the time of Trajan, who bestowed on him the consular ornaments, and also caused an edict to be passed, that the magistrates or officers of Illyria should do nothing in that province without his knowledge and approbation."

When and how he was made known to Trajan is likewise uncertain: but it is generally supposed that Trajan, a private man when Plutarch first came to Rome, was, among other nobility, one of his auditors. It is also supposed, that this wise emperor made use of him in his councils; at least, much of the happiness of his reign has been imputed to Plutarch. Fabricius asserts that he was Trajan's preceptor, and that he was raised to the consular dignity by him, and made procurator of Greece in his old age by the emperor Adrian. We are equally at a loss concerning the time of his abode in the imperial city; which, however, at different times, is not imagined to fall much short of 40 years. The desire of visiting his native country, so natural to all men, and especially when growing old, prevailed with him at length to leave Italy: and at his return he was unanimously chosen archon or chief magistrate of Chersonesus, and not long after admitted into the number of the Delphic Apollo's priests. We have no particular account of his death, either as to the manner of it or the year; only it is evident that he lived, and continued his studies, to a good old age. The most probable conjecture is that of Fabricius, who says he died in the fifth year of Adrian at the age of 70.

His works have been divided, and they admit of a pretty equal division, into Lives and Morals: the former of which, in his own estimation, were to be preferred as more noble than the latter. His style, as we have already observed, has been excepted to with some reason: he has also been criticised for some mistakes in Roman antiquities, and for a little partiality to the Greeks. On the other hand, he has been justly praised

for the copiousness of his fine sense and learning, for his integrity, and for a certain air of goodness which appears in all he wrote. His business was not to please the ear, but to instruct and charm the mind; and in this none ever went beyond him. Of his moral writings it is to be regretted that we have no elegant English translation. Even his Lives were chiefly known to the English reader by a motley and miserable version, till a new one executed with fidelity and spirit was presented to the public by the Langhorns in 1770. On the whole, it is to be wished that this most amiable moralist and biographer had added a life of himself to those which he has given to the world of others, as the particulars which other writers have preserved of his personal history are very doubtful and imperfect.

PLUTO, in Pagan worship, the king of the infernal regions, was the son of Saturn and Ops, and the brother of Jupiter and Neptune. This deity finding himself childless and unmarried, mounted his chariot to visit the world; and arriving in Sicily, fell in love with Proserpine, whom he saw gathering flowers with her companions in the valley of Enna, near mount Aetna: when, forcing her into his chariot, he drove her to the river Chemarus, through which he opened himself a passage back to the realms of night. See CERES and PROSERPINE.

Pluto is usually represented in an ebony chariot drawn by four black horses; sometimes holding a sceptre, to denote his power; at others, a wand, with which he drives away the ghosts; and at others, some keys, to signify that he had the keys of death. Homer observes, that his helmet had the quality of rendering the wearer invisible, and that Minerva borrowed it in order to be concealed from Mars when she fought against the Trojans. Pluto was greatly revered both by the Greeks and Romans, who erected temples and altars to him. To this god sacrifices were offered in the night, and it was not lawful to offer them by day.

PLUTUS, in Pagan worship, the god of riches, is frequently confounded with Pluto. He was represented as appearing lame when he approached, and with wings at his departure; to show the difficulty of attaining wealth, and the uncertainty of its enjoyment. He was also frequently represented blind, to show that he often bestowed his favours on the most unworthy, and left in necessity those who had the greatest merit.

PLUVIALIS. See CHARADRIUS, n° 7.

PLUVIUS, a surname of Jupiter. He was invoked by that name among the Romans whenever the earth was parched up by continual heat, and was in want of refreshing rains. He had an altar in the temple on the capitol.

PLYERS, in fortification, denote a kind of balance used in raising or letting down a draw-bridge. They consist of two timber levers, twice as long as the bridge they lift, joined together by other timbers framed in the form of a St Andrew's cross to counterpoise them. They are supported by two upright jacks, on which they swing; and the bridge is raised or let down by means of chains joining the ends of the plyers and bridge.

PLYING, in the sea language, the act of making, or endeavouring to make, a progress against the direction of the wind. Hence a ship that advances well in her course in this manner of sailing, is said to be a good plying.

Pluto
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Plying.

Plymouth. plyer. See the articles BEATING, PITCHING, and TACKING.

PLYMOUTH, a town of Devonshire, in England, about 215 miles from London, stands between the rivers Plym and Tamar, just before they fall into the British Channel. From a mere fishing village it has become one of the largest towns in the county; and is one of the chief magazines in the kingdom, on account of its port, which is one of the safest in England, and which is so large as to be able to contain 1000 sail. It is defended by several different forts, mounting altogether nearly 300 guns; of which the chief is the Royal Citadel, erected in the reign of Charles II. opposite to St Nicholas Island, which is within the circuit of its walls, and contains a large store-house and five regular bastions. In time of war the outward-bound convoys generally rendezvous at Plymouth, and homeward-bound ships generally put in to provide pilots up the Channel. It is also a great place of resort for men of war that are wind-bound.

The mouth of the Tamar is called Ham-Ooze, and that of Plym Catwater, which are both commanded by the castle on St Nicholas Island. About two miles up the mouth of the Tamar there are four docks, two of which were built in the reign of William III. one wet and the other dry, and two which have been built since. They have every conveniency for building or repairing ships, and one of them is hewn out of a mine of slate and lined with Portland stone. This town enjoys a pilchard fishery of considerable importance, and carries on an extensive trade with Newfoundland and the Straits. There is a customhouse in it; and though there are two churches (and besides several meeting-houses), yet each church has so large a cure of souls, that the parish clerks were till very lately in deacon's orders, to enable them to perform all the occasional and other offices. The feat-rents are given to the poor. The lecturers are chosen every three years by the corporation, which was constituted by Henry VI. and consists of a mayor, 12 aldermen, and 24 common-council men. The mayor is elected by a jury of 36 persons, chosen by four others, two of whom are appointed by the mayor and aldermen, and the other two by the common-council. There is also a recorder, and a town-clerk, whose place is very profitable. The town consists of four divisions, which were anciently governed by four captains, each of whom had three constables under him. It is well supplied with fresh water, which was brought from the distance of seven miles, by Sir Francis Drake a native of the town. The toll of the markets, and of the cotton, yarn, &c. with the profit of the mill, which is very considerable, belongs to the corporation, as do the revenues of the shambles, which are farmed out for the mayor's kitchen. There is a charity-school in Plymouth, four hospitals, and a workhouse, in all which 100 poor children are clothed, fed, and taught; and there are two printing-houses. To one of the hospitals Colonel Jory gave a charity for 12 poor widows, as he did a mace worth 120*l.* to be carried before the mayor, and

fix good bells, valued at 500*l.* to Charles-Church, so called from our kings in whose reigns it was begun and finished. In the entrance of the bay lies the famous Edystone-rock, which is covered at high-water, and on which the ingenious Mr Winstanley built a light-house, that was blown down in the terrible hurricane of Nov. 27th 1703, and himself, with others that were with him in it, never more heard of. However, another was erected in the room of it, by the corporation of the Trinity-house, in pursuance of an act of the 5th of Queen Anne, which was destroyed by an accidental fire Dec. 4th 1755, but rebuilt in 1759: which also was burnt down, and rebuilt in the year 1770. In the reign of Edward III. the French landed, and burnt part of the town, but were soon repulsed by Hugh Courtenay earl of Devon. In the reign of Henry IV. the French landed here again, and burnt 600 houses. Between this town and the sea is a hill called the Haw, which has a delightful plain on the top, having a pleasant prospect all round it, and a good landmark for the use of mariners. The list of parliament-men for this borough, formerly divided into two parts, by the names of Sutton-Valtort and Sutton-Prior, commences the 26th of Edward I. and continues to the 14th of Edward III. after which we find no return made for it till the 20th of Henry VI. when the privilege was renewed. On the Haw is a fort, which at once awes the town and defends the harbour. Here is a ferry over the Tamar, called Crumwell or Crimble Passage, the west side of which is called Westone-House, and is in Devonshire, though most of the parish wherein it stands is in Cornwall. In April 1759 the parliament granted 25,150*l.* for the better fortifying the town and dock of Plymouth; which was visited by George III. with the Queen, &c. in August 1789. N. Lat. 50. 26. W. Long. 4. 15.

PLYMOUTH, in New England, a sea-port town, and capital of the county of the same name, in the province of Massachusetts Bay, in North America. It is remarkable for having been the first settlement in New England, and for having had the first place of worship. It is seated at the south end of Plymouth Bay. W. Long. 70. 10. N. Lat. 41. 58.

PLYNTERIA, a Grecian festival in honour of Aglauros, or rather of Minerva, who received from the daughter of Cecrops the name of Aglauros. The word is derived from *πλυννιν*, *lavare*, because during the solemnity they undressed the statue of the goddess and washed it. The day on which it was observed was looked upon as unfortunate and inauspicious; and therefore no person was permitted to appear in the temples, as they were purposely surrounded with ropes. The arrival of Alcibiades in Athens that day was thought very unfortunate, but the success that ever after attended him proved it to be otherwise. It was customary at this festival to bear in procession a cluster of figs; which intimated the progress of civilization among the first inhabitants of the earth, as figs served them for food after they had found a dislike for acorns.

P N E U M A T I C S.

Definition
of term.

THIS term is restricted, in the present habits of our language, to that part of natural philosophy which treats of the mechanical properties of elastic fluids. The word, in its original meaning, expresses a quality of air, or more properly of breath. Under the article *PHYSICS* we observed, that in a great number of languages the term used to express breath was also one of the terms used to express the animating principle, nay, the intellectual substance, the soul. It has been perhaps owing to some attention to this chance of confusion that our philosophers have appropriated the term *PNEUMATICS* to the science of the mechanical properties of air, and *PNEUMATOLOGY* to the science of the intellectual phenomena consequent on the operations or affections of our thinking principle.

Extent of
the science

We have extended (on the authority of present custom) the term *PNEUMATICS* to the study of the mechanical properties of all elastic or sensibly compressible fluids, that is, of fluids whose elasticity and compressibility become an interesting object of our attention; as the term *HYDROSTATICS* is applied to the study of the mechanical properties of such bodies as interest us by their fluidity or liquidity only, or whose elasticity and compressibility are not familiar or interesting, though not less real or general than in the case of air and all vapours.

No precise
limit to the
different
classes of
bodies.

We may be indulged in the observation by the bye, that there is no precise limit to the different classes of natural bodies with respect to their mechanical properties. There is no such thing as a body perfectly hard, perfectly soft, perfectly elastic, or perfectly incompressible. All bodies have some degree of elasticity intermixed with some degree of ductility. Water, mercury, oil, are compressible; but their compressibility need not be attended to in order perfectly to understand the phenomena consequent on their materiality, fluidity, and gravity. But if we neglect the compressibility of air, we remain ignorant of the cause and nature of its most interesting phenomena, and but imperfectly informed with respect to those in which its elasticity has no share; and it is convenient to attend to this distinction in our researches, in order to understand those phenomena which depend solely or chiefly on compressibility and elasticity. This observation is important; for here elasticity appears in its most simple form, unaccompanied with any other mechanical affection of matter (if we except gravity), and lies most open to our observation, whether employed for investigating the nature of this very property of bodies, or for explaining its mode of action. We shall even find that the constitution of an avowedly elastic fluid, whose compressibility is so very sensible, will give us the distinctest notions of fluidity in general, and enable us to understand its *characteristic appearances*, by which it is distinguished from solidity, namely, the *equable* distribution of pressure thro' all its parts in every direction, and the horizontality which its surface assumes by the action of gravity: phenomena which have been assumed as equivalent to the definition of a perfect fluid, and from which all the laws of hydrostatics and hydraulics have been derived. And

these laws have been applied to the explanation of the phenomena around us; and water, mercury, oil, &c. have been denominated fluid only because their appearances have been found to tally exactly with these consequences of this definition, while the definition itself remains in the form of an assumption, unsupported by any other proof of its obtaining in nature. A real mechanical philosopher will therefore attach himself with great eagerness to this property, and consider it as an introduction to much natural science.

Of all the sensibly compressible fluids air is the most familiar, was the first studied, and the most minutely examined. It has therefore been generally taken as the example of their mechanical properties, while those mechanical properties which are peculiar to any of them, and therefore characteristic, have usually been treated as an appendix to the general science of pneumatics. No objection occurs to us against this method, which will therefore be adopted in treating this article.

But although the mechanical properties are the proper subjects of our consideration, it will be impossible to avoid considering occasionally properties which are more of a chemical nature; because they occasion such modifications of the mechanical properties as would frequently be unintelligible without considering them in conjunction with the other; and, on the other hand, the mechanical properties produce such modifications of the properties merely chemical, and of very interesting phenomena consequent on them, that these would often pass unexplained unless we give an account of them in this place.

By *mechanical properties* we would be understood to mean such as produce, or are connected with, sensible changes of motion, and which indicate the presence and agency of moving or mechanical powers. They are therefore the subject of mathematical discussion; admitting of measure, number, and direction, notions purely mathematical.

We shall therefore begin with the consideration of air.

It is by no means an idle question, "What is this air of which so much is said and written?" We see nothing, we feel nothing. We find ourselves at liberty to move about in any direction without any let or hindrance. Whence, then, the assertion, that we are surrounded with a *matter* called air? A few very simple observations and experiments will show us that this assertion is well founded.

We are accustomed to say, that a vessel is empty when we have poured out of it the water which it contained. Take a cylindrical glass jar (fig. 1.), having a small hole in its bottom; and having stopped this hole, fill the jar with water, and then pour out the water, leaving the glass empty, in the common acceptance of the word. Now, throw a bit of cork, or any light body, on the surface of water in a cistern: cover this with the glass jar held in the hand with its bottom upwards, and move it downwards, keeping it all the while in an upright position. The cork will continue to float on the surface of the water in the inside of the glass.

and will most distinctly show whereabouts that surface is. It will thus be seen, that the water within the glass has its surface considerably lower than that of the surrounding water; and however deep we immerge the glass, we shall find that the water will never rise in the inside of it so as to fill it. If plunged to the depth of 32 feet, the water will only half fill it; and yet the acknowledged laws of hydrostatics tell us, that the water would fill the glass if there were nothing to hinder it. There is therefore something already within the glass which prevents the water from getting into it; manifesting in this manner the most distinctive property of matter, viz. the hindering other matter from occupying the same place at the same time.

9
Possessed of
impulsive
force,

While things are in this condition, pull the stopper out of the hole in the bottom of the jar, and the water will instantly rise in the inside of the jar, and stand at an equal height within and without. This is justly ascribed to the escape through the hole of the matter which formerly obstructed the entry of the water: for if the hand be held before the hole, a puff will be distinctly felt, or a feather held there will be blown aside; indicating in this manner that what prevented the entry of the water, and now escapes, possesses another characteristic property of matter, *impulsive force*. The materiality is concluded from this appearance in the same manner that the materiality of water is concluded from the impulse of a jet from a pipe. We also see the mobility of the formerly pent up, and now liberated, substance, in consequence of external pressure, viz. the pressure of the surrounding water.

10
Impenetrability,

Also, if we take a smooth cylindrical tube, shut at one end, and fit a plug or cork to its open end, so as to slide along it, but so tightly as to prevent all passage by its sides; and if the plug be well soaked in grease, we shall find that no force whatever can push it to the bottom of the tube. There is therefore *something* within the tube preventing by its impenetrability the entry of the plug, and therefore possessing this characteristic of matter.

11
Elasticity,

In like manner, if, after having opened a pair of common bellows, we shut up the nozzle and valve hole, and try to bring the boards together, we find it impossible. There is something included which prevents this, in the same manner as if the bellows were filled with wool; but on opening the nozzle we can easily shut them, viz. by expelling this something; and if the compression is forcible, the something will issue with considerable force, and very sensibly impel any thing in its way.

12
Inertia, and
mobility.

It is not accurate to say, that we move about without any obstruction; for we find, that if we endeavour to move a large fan with rapidity, a very sensible hindrance is perceived, and that a very sensible force must be exerted; and a sensible wind is produced, which will agitate the neighbouring bodies. It is therefore justly concluded that the motion is possible only in consequence of having driven this obstructing substance out of the way; and that this impenetrable, resisting, moveable, impelling substance, is *matter*. We perceive the perseverance of this matter in its state of rest when we wave a fan, in the same manner that we perceive the *inertia* of water when we move a paddle through it. The effects of wind in impelling our ships and mills, in

tearing up trees, and overturning buildings, are equal indications of its perseverance in a state of motion.

To this matter, when at rest, we give the name *AIR*; and when it is in motion we call it *WIND*.

Air, therefore, is a material fluid: a fluid, because its parts are easily moved, and yield to the smallest inequality of pressure. 13
It is there-
fore a ma-
terial fluid,
14
Heavy, and

Air possesses some others of the very general, though not essential, properties of matter. It is heavy. This appears from the following facts.

1. It always accompanies this globe in its orbit round the sun, surrounding it to a certain distance, under the name of the *ATMOSPHERE*, which indicates the being connected with the earth by its general force of gravity. It is chiefly in consequence of this that it is continually moving round the earth from east to west; forming what is called the trade-wind, to be more particularly considered afterwards. All that is to be observed on this subject at present is, that, in consequence of the disturbing force of the sun and moon, there is an accumulation of the air of the atmosphere, in the same manner as of the waters of the ocean, in those parts of the globe which have the moon near their zenith or nadir; and as this happens successively, going from the east to the west (by the rotation of the earth round its axis in the opposite direction), the accumulated air must gradually flow along to form the elevation. This is chiefly to be observed in the torrid zone; and the generality and regularity of this motion are greatly disturbed by the changes which are continually taking place in different parts of the atmosphere from causes which are not mechanical.

2. It is in like manner owing to the gravity of the air that it supports the clouds and vapours which we see constantly floating in it. We have even seen bodies of no inconsiderable weight float, and even rise, in the air. Soap bubbles, and balloons filled with inflammable gas, rise and float in the same manner as a cork rises in water. This phenomenon proves the weight of the air in the same manner that the swimming of a piece of wood indicates the weight of the water which supports it. 15
Supports the clouds

3. But we are not left to these refined observations for the proof of the air's gravity. We may observe familiar phenomena, which would be immediate consequences of the supposition that air is a heavy fluid, and, like other heavy fluids, presses on the outsidings of all bodies immersed in or surrounded by it. Thus, for instance, if we shut the nozzle and valve hole of a pair of bellows after having squeezed the air out of them, we shall find that a very great force, even some hundred pounds, is necessary for separating the boards. They are kept together by the pressure of the heavy air which surrounds them in the same manner as if they were immersed in water. In like manner, if we stop the end of a syringe after its piston has been pressed down to the bottom, and then attempt to draw up the piston, we shall find a considerable force necessary, viz. about 15 or 16 pounds for every square inch of the section of the syringe. Exerting this force, we can draw up the piston to the top, and we can hold it there; but the moment we cease acting, the piston rushes down and strikes the bottom. It is called a suction, as we feel something as if it were drawing in the piston; but it is really the weight of 16
Familiar
proof of
weight

of the incumbent air pressing it in. And this obtains in every position of the syringe; because the air is a fluid, and presses in every direction. Nay, it presses on the syringe as well as on the piston; and if the piston be hung by its ring on a nail, the syringe requires force to draw it down (just as much as to draw the piston up); and if it be let go, it will spring up, unless loaded with at least 15 pounds for every square inch of its transverse section (see fig. 2.)

4. But the most direct proof of the weight of the air is had by weighing a vessel empty of air, and then weighing it again when the air has been admitted; and this, as it is the most obvious consequence of its weight, has been asserted as long ago as the days of Aristotle. He says (*περί οὐρανοῦ*, iv. 4.), That all bodies are heavy in their place except fire: even air is heavy; for a blown bladder is heavier than when it is empty. It is somewhat surprising that his followers should have gone into the opposite opinion, while professing to maintain the doctrine of their leader. If we take a very large and limber bladder, and squeeze out the air very carefully, and weigh it, and then fill it till the wrinkles just begin to disappear, and weigh it again, we shall find no difference in the weight. But this is not Aristotle's meaning; because the bladder, considered as a vessel, is equally full in both cases, its dimensions being changed. We cannot take the air out of a bladder without its immediately collapsing. But what would be true of a bladder would be equally true of any vessel. Therefore, take a round vessel A (fig. 3.), fitted with a stopcock B, and syringe C. Fill the whole with water, and press the piston to the bottom of the syringe. Then keeping the cock open, and holding the vessel upright, with the syringe undermost, draw down the piston. The water will follow it by its weight, and leave part of the vessel empty. Now shut the cock, and again push up the piston to the bottom of the syringe; the water escapes through the piston valve, as will be explained afterward: then opening the cock, and again drawing down the piston, more water will come out of the vessel. Repeat this operation till all the water have come out. Shut the cock, unscrew the syringe, and weigh the vessel very accurately. Now open the cock, and admit the air, and weigh the vessel again, it will be found heavier than before, and this additional weight is the weight of the air which fills it; and it will be found to be 523 grains, about an ounce and a fifth avoirdupoise, for every cubic foot that the vessel contains. Now since a cubic foot of water would weigh 1000 ounces, this experiment would show that water is about 840 times heavier than air. The most accurate judgment of this kind of which we have met with an account is that recorded by Sir George Shuckburgh, which is in the 67th vol. of the Philosophical Transactions, p. 560. From this it follows, that when the air is of the temperature 53, and the barometer stands at 29½ inches, the air is 836 times lighter than water. But the experiment is not susceptible of sufficient accuracy for determining the exact weight of a cubic foot of air. Its weight is very small; and the vessel must be strong and heavy, so as to overload any balance that is sufficiently nice for the experiment.

To avoid this inconvenience, the whole may be weighed in water, first loading the vessel so as to make it preponderate an ounce or two in the water. By this

means the balance will be loaded only with this small preponderancy. But even in this case there are considerable sources of error, arising from changes in the specific gravity of the water and other causes. The experiment has often been repeated with this view, and the air has been found at a medium to be about 840 times as light as water, but with great variations, as may be expected from its very heterogeneous nature, in consequence of its being the menstruum of almost every fluid, of all vapours, and even of most solid bodies; all which it holds in solution, forming a fluid perfectly transparent, and of very different density according to its composition. It is found, for instance, that perfectly pure air of the temperature of our ordinary summer is considerably denser than when it has dissolved about half as much water as it can hold in that temperature; and that with this quantity of water the difference of density increases in proportion as the mass grows warmer, for damp air is more expansible by heat than dry air. We shall have occasion to consider this subject again, when we treat of the connection of the mechanical properties of air with the state of the weather. See WEATHER.

Such is the result of the experiment suggested by Aristotle, evidently proving the weight of the air; and yet, as has been observed, the Peripatetics, who profess to follow the *dictates* of Aristotle, uniformly refused it this property. It was a matter long debated among the philosophers of the last century. The reason was, that Aristotle, with that indistinctness and inconsistency which is observed in all his writings which relate to matters of fact and experience, assigns a different cause to many phenomena which any man led by common observation would ascribe to the weight of the air. Of this kind is the rise of water in pumps and syphons, which all the Peripatetics had for ages ascribed to something which they called *nature's abhorrence of a void*. Aristotle had asserted (for reasons not our business to adduce at present), that all nature was full of being, and that nature abhorred a void. He adduces many facts, in which it appears, that if not absolutely impossible, it is very difficult, and requires great force, to produce a space void of matter. When the operation of pumps and syphons came to be known, the philosophers of Europe (who had all embraced the Peripatetic doctrines) found in this fancied horror of a fancied mind (what else is this that nature abhors?) a ready solution of the phenomena. We shall state the facts, that every reader may see what kinds of reasoning were received among the learned not two centuries ago.

Pumps were then constructed in the following manner: A long pipe GB (fig. 4.) was set in the water of the well A. This was fitted with a sucker or piston C, having a long rod CF, and was furnished with a valve B at the bottom, and a lateral pipe DE at the place of delivery, also furnished with a valve. The fact is, that if the piston be thrust down to the bottom, and then drawn up, the water will follow it; and upon the piston being again pushed down, the water shuts the valve B by its weight, and escapes or is expelled at the valve E; and on drawing up the piston again the valve E is shut, the water again rises after the piston, and is again expelled at its next descent.

The Peripatetics explain all this by saying, that if the water did *not follow the piston* there would be a void between

21 Their operation accounted for by the Peripatetics. between them. But nature abhors a void; or a void is impossible: therefore the water follows the piston.— It is not worth while to criticise the wretched reasoning in this pretence to explanation. It is all overturned by one observation. Suppose the pipe shut at the bottom, the piston *can* be drawn up, and thus a void produced. No, say the Peripatetics; and they speak of certain spirits, effluvia, &c. which occupy the place. But if so, why needs the water rise? This therefore is not the cause of its ascent. It is a curious and important phenomenon.

22 Galileo first accounted for it rationally. The sagacious Galileo seems to have been the first who seriously ascribed this to the weight of the air. Many before him had supposed air heavy; and thus explained the difficulty of raising the board of bellows, or the piston of a syringe, &c. But he distinctly applies to this allowed weight of the air all the consequences of hydrostatical laws; and he reasons as follows.

23 By the weight of the atmosphere, The heavy air rests on the water in the cistern, and presses it with its weight. It does the same with the water in the pipe, and therefore both are on a level: but if the piston, after being in contact with the surface of the water, be drawn up, there is no longer any pressure on the surface of the water within the pipe; for the air now rests on the piston only, and thus occasions a difficulty in drawing it up. The water in the pipe, therefore, is in the same situation as if more water were poured into the cistern, that is, as much as would exert the same pressure on its surface as the air does. In this case we are certain that the water will be pressed into the pipe, and will raise up the water already in it, and follow it till it is equally high within and without. The same pressure of the air shuts the valve E during the descent of the piston. (See *Gal. Discourses*.)

24 And predicted the height to which water would rise in them. He did not wait for the very obvious objection, that if the rise of the water was the effect of the air's pressure, it would also be its measure, and would be raised and supported only to a certain height. He directly said so, and adduced this as a decisive experiment. If the horror of a void be the cause, says he, the water must rise to any height however great; but if it be owing to the pressure of the air, it will only rise till the weight of the water in the pipe is in equilibrio with the pressure of the air, according to the common laws of hydrostatics. And he adds, that this is well known; for it is a fact, that pumps will not *draw* water much above forty palms, although they may be made to *propel* it, or to *lift* it to any height. He then makes an assertion, which, if true, will be decisive. Let a very long pipe, shut at one end, be filled with water, and let it be erected perpendicularly with the close end uppermost, and a stopper in the other end, and then its lower orifice immersed into a vessel of water; the water will subside in the pipe upon removing the stopper, till the remaining column is in equilibrio with the pressure of the external air. This experiment he proposes to the curious; saying, however, that he thought it unnecessary, there being already such abundant proofs of the air's pressure.

25 His prediction verified by Toricelli's experiment. It is probable that the cumberfomeness of the necessary apparatus protracted the making of this experiment. Another equally conclusive, and much easier, was made in 1642 after Galileo's death, by his zealous and learned disciple Toricelli. He filled a glass tube, close at one end, with mercury; judging, that if the support of the water

was owing to the pressure of the air, and was the measure of this pressure, mercury would in like manner be supported by it, and this at a height which was also the measure of the air's pressure, and therefore 13 times less than water. He had the pleasure of seeing his expectation verified in the completest manner; the mercury descending in the tube AB (fig. 5.), and finally settling at the height *f*B of 29½ Roman inches: and he found, that when the tube was inclined, the point *f* was in the same horizontal plane with *f* in the upright tube, according to the received laws of hydrostatical pressure. The experiment was often repeated, and soon became famous, exciting great controversies among the philosophers about the possibility of a vacuum. About three years afterwards the same experiment was published, at Warsaw in Poland, by Valerianus Magnus as his own suggestion and discovery: but it appears plain from the letters of Roberval, not only that Toricelli was prior, and that his experiment was the general topic of discussion among the curious; but also highly probable that Valerianus Magnus was informed of it when at Rome, and daily conversant with those who had seen it. He denies, however, even having heard of the name of Toricelli.

This was the era of philosophical ardour; and we think that it was Galileo's invention and immediate application of the telescope which gave it vigour. Discoveries of the most wonderful kind in the heavens, and which required no extent of previous knowledge to understand them, were thus put into the hands of every person who could purchase a spy-glass; while the high degree of credibility which some of the discoveries, such as the phases of Venus and the rotation and satellites of Jupiter, gave to the Copernican system, immediately set the whole body of the learned in motion. Galileo joined to his ardour a great extent of learning, particularly of mathematical knowledge and sound logic, and was even the first who formally united mathematics with physics; and his treatise on accelerated motion was the first, and a precious fruit of this union. About the years 1642 and 1644, we find clubs of gentlemen associated in Oxford and London for the cultivation of knowledge by experiment; and before 1655 all the doctrines of hydrostatics and pneumatics were familiar there, established upon experiment. Mr Boyle procured a coalition and correspondence of these clubs under the name of the Invisible and Philosophical Society. In May 1658 Mr Hooke finished for Mr Boyle an air-pump, which had employed him a long time, and occasioned him several journeys to London for things which the workmen of Oxford could not execute. He speaks of this as a great improvement on Mr Boyle's own pump, which he had been using some time before. Boyle therefore must have invented his air-pump, and was not indebted for it to Schottus's account of Otto Guericke's, published in his (Schottus) *Mechanica Hydro-pneumatica* in 1657, as he asserts (*Techna Curiosa*). The Royal Society of London arose in 1656 from the coalition of these clubs, after 15 years co-operation and correspondence. The Montmorine Society at Paris had subsisted nearly about the same time; for we find Paschal in 1648 speaking of the meetings in the Sorbonne College, from which we know that society originated.—Nuremberg, in Germany, was also a distinguished seminary of experimental philosophy. The

magistrates, sensible of its valuable influence in manufactures, the source of the opulence and prosperity of their city, and many of them philosophers, gave philosophy a professed and munificent patronage, furnishing the philosophers with a copious apparatus, a place of assembly, and a fund for the expence of their experiments; so that this was the first academy of sciences out of Italy under the patronage of government. In Italy, indeed, there had long existed institutions of this kind. Rome was the centre of church-government, and the resort of all expectants for preferment. The clergy were the majority of the learned in all Christian nations, and particularly of the systematic philosophers. Each, eager to recommend himself to notice, brought forward every thing that was curious; and they were the willing vehicles of philosophical communication. Thus the experiments of Galileo and Toricelli were rapidly diffused by persons of rank, the dignitaries of the church, or by the monks their obsequious servants. Perhaps the recent defection of England, and the want of a residing embassy at Rome, made her sometimes late in receiving or spreading philosophical researches, and was the cause that more was done there *proprio Marte*.

We hope to be excused for this digression. We were naturally led into it by the pretensions of Valerianus Magnus to originality in the experiment of the mercury supported by the pressure of the air. Such is the strength of national attachment, that there were not wanting some who found that Toricelli had borrowed his experiment from Honoratus Fabri, who had proposed and explained it in 1641; but whoever knows the writings of Toricelli, and Galileo's high opinion of him, will never think that he could need such helps. (See this surmise of Mounier in *Schott. Tech. Cur.* III. at the end.

Galileo must be considered as the author of the experiment when he proposes it to be made. Valerianus Magnus owns himself indebted to him for the principle and the contrivance of the experiment. It is neither wonderful that many ingenious men, of one opinion, and instructed by Galileo, should separately hit on so obvious a thing; nor that Toricelli, his immediate disciple, his enthusiastic admirer, and who was in the habits of corresponding with him till his death in 1642, should be the first to put it in practice. It became the subject of dispute from the national arrogance and self-conceit of some Frenchmen, who have always shown themselves disposed to consider their nation as at the head of the republic of letters, and cannot brook the concurrence of any foreigners. Roberval was in this instance, however, the champion of Toricelli; but those who know his controversies with the mathematicians of France at this time will easily account for this exception.

All now agree in giving Toricelli the honour of the first invention; and it universally passes by the name of the TORICELLIAN EXPERIMENT. The tube is called the TORICELLIAN TUBE; and the space left by the mercury is called the TORICELLIAN VACUUM, to distinguish it from the BOYLEAN VACUUM, which is only an extreme rarefaction.

The experiment was repeated in various forms, and with apparatus which enabled philosophers to examine several effects which the vacuum produced on bodies exposed in it. This was done by making the upper

part of the tube terminate in a vessel of some capacity, or communicate with such a vessel, in which were included along with the mercury bodies on which the experiments were to be made. When the mercury had run out, the phenomena of these bodies were carefully observed.

An objection was made to the conclusion drawn from Toricelli's experiment, which appears formidable. If the Toricellian tube be suspended on the arm of a balance, it is found that the counterpoise must be equal to the weight both of the tube and of the mercury it contains. This could not be, say the objectors, if the mercury were supported by the air. It is evidently supported by the balance; and this gave rise to another notion of the cause different from the peripatetic *suga vacui*: a suspensive force, or rather attraction, was assigned to the upper part of the tube.

But the true explanation of the phenomenon is most easy and satisfactory. Suppose the mercury in the cistern and tube to freeze, but without adhering to the tube, so that the tube could be freely drawn up and down. In this case the mercury is supported by the base, without any dependence on the pressure of the air; and the tube is in the same condition as before, and the solid mercury performs the office of a piston to this kind of syringe. Suppose the tube thrust down till the top of it touches the top of the mercury. It is evident that it must be drawn up in opposition to the pressure of the external air, and it is precisely similar to the syringe mentioned in n° 16. The weight sustained therefore by this arm of the balance is the weight of the tube and the downward pressure of the atmosphere on its top.

The curiosity of philosophers being thus excited by this very manageable experiment, it was natural now to try the original experiment proposed by Galileo. Accordingly Berti in Italy, Paschal in France, and many others in different places, made the experiment with a tube filled with water, wine, oil, &c. and all with the success which might be expected in so simple a matter: and the doctrine of the weight and pressure of the air was established beyond contradiction or doubt. All was done before the year 1648.—A very beautiful experiment was exhibited by Auzout, which completely satisfied all who had any remaining doubts.

A small box or phial EFGH (fig. 6.) had two glass tubes, AB, CD, three feet long, inserted into it in such a manner as to be firmly fixed in one end, and to reach nearly to the other end. AB was open at both ends, and CD was close at D. This apparatus was completely filled with mercury, by unscrewing the tube AB, filling the box, and the hole CD; then screwing in the tube AB, and filling it: then holding a finger on the orifice A, the whole was inverted and set upright in the position represented in figure 6, immersing the orifice A (now *a*) in a small vessel of quicksilver. The result was, that the mercury ran out at the orifice *a*, till its surface *mn* within the phial descended to the top of the tube *ba*. The mercury also began to descend in the tube *dc* (formerly DC) and run over into the tube *ba*, and ran out at *a*, till the mercury in *dc* was very near equal in a level with *mn*. The mercury descending in *ba* till it stood at *k*, 29½ inches above the surface *op* of the mercury in the cistern, just as in the Toricellian tube.

The rationale of this experiment is very easy. The whole apparatus may first be considered as a Toricellian tube of an uncommon shape, and the mercury would flow out at *a*. But as soon as a drop of mercury comes out, leaving a space above *mn*, there is nothing to keep up the mercury in the tube *dc*. Its mercury therefore descends also; and running over into *ba*, continues to supply its expanse till the tube *dc* is almost empty, or can no longer supply the waste of *ba*: The inner surface therefore falls as low as it can, till it is level with *l*. No more mercury can enter *ba*, yet its column is too heavy to be supported by the pressure of the air on the mercury in the cistern below; it therefore descends in *ba*, and finally settles at the height *ke*, equal to that of the mercury in the Toricellian tube.

35
Decisive of
the ques-
tion.

The prettiest circumstance of the experiment remains. Make a small hole *g* in the upper cap of the box. The external air immediately rushes in by its weight, and now presses on the mercury in the box. This immediately raises the mercury in the tube *dc* to *l*, 29½ inches above *mn*. It presses on the mercury at *k* in the tube *ba*, balancing the pressure of the air in the cistern. The mercury in the tube therefore is left to the influence of its own weight, and it descends to the bottom. Nothing can be more apposite or decisive.

36
The gravi-
ty of the
air there-
fore a sta-
tical prin-
ciple from
which we
obtain

And thus the doctrine of the gravity and pressure of the air is established by the most unexceptionable evidence: and we are intitled to assume it as a statical principle, and to affirm *a priori* all its legitimate consequences.

And in the first place, we obtain an exact measure of the pressure of the atmosphere. It is precisely equal to the weight of the column of mercury, of water, of oil, &c. which it can support; and the Toricellian tube, or others fitted up upon the same principle, are justly termed *baroscopes* and *barometers* with respect to the air. Now it is observed that water is supported at the height of

37
An exact
measure of
the pressure
of the at-
mosphere

32 feet nearly: The weight of the column is exactly 2000 avoirdupois pounds on every square foot of base, or 13½ on every square inch. The same conclusion very nearly may be drawn from the column of mercury, which is nearly 29½ inches high when in equilibrium with the pressure of the air. We may here observe, that the measure taken from the height of a column of water, wine, spirits, and the other fluids of considerable volatility, as chemists term it, is not so exact as that taken from mercury, oil, and the like. For it is observed, that the volatile fluids are converted by the ordinary heat of our climates into vapour when the confining pressure of the air is removed; and this vapour, by its elasticity, exerts a small pressure on the surface of the water, &c. in the pipe, and thus counteracts a small part of the external pressure; and therefore the column supported by the remaining pressure must be lighter, that is, shorter. Thus it is found, that rectified spirits will not stand much higher than is competent to a weight of 13 pounds on an inch, the elasticity of its vapour balancing about ⅓ of the pressure of the air. We shall afterwards have occasion to consider this matter more particularly.

As the medium height of the mercury in the barometer is 29½ inches, we see that the whole globe sustains a pressure equal to the whole weight of a body of mercury of this height; and that all bodies on its surface

sustain a part of this in proportion to their surfaces. An ordinary sized man sustains a pressure of several thousand pounds. How comes it then that we are not sensible of a pressure which one should think enough to crush us together? This has been considered as a strong objection to the pressure of the air; for when a man is plunged a few feet under water, he is very sensible of the pressure. The answer is by no means so easy as is commonly imagined. We feel very distinctly the effects of removing this pressure from any part of the body. If any one will apply the open end of a syringe to his hand, and then draw up the piston, he will find his hand sucked into the syringe with great force, and it will give pain; and the soft part of the hand will swell into it, being pressed in by the neighbouring parts, which are subject to the action of the external air. If one lays his hand on the top of a long perpendicular pipe, such as a pump filled to the brim with water, which is at first prevented from running out by the valve below; and if the valve be then opened, so that the water descends, he will then find his hand so hard pressed to the top of the pipe that he cannot draw it away. But why do we only feel the *inequality* of pressure? There is a similar instance wherein we do not feel it, although we cannot doubt of its existence. When a man goes slowly to a great depth under water in a diving-bell, we know unquestionably that he is exposed to a new and very great pressure, yet he does not feel it. But those facts are not sufficiently familiar for general argument. The human body is a bundle of solids, hard or soft, filled or mixed with fluids, and there are few or no parts of it which are empty. All communicate either by vessels or pores; and the whole surface is a sieve through which the insensible perspiration is performed. The whole extended surface of the lungs is open to the pressure of the atmosphere; every thing is therefore in equilibrio: and if ease or speedy access be given to every part, the body will not be damaged by the pressure, however great, any more than a wet sponge would be deranged by plunging it any depth in water. The pressure is instantaneously diffused by means of the incompressible fluids with which the parts are filled; and if any parts are filled with air or other compressible fluids, these are compressed till their elasticity again balances the pressure. Besides, all our fluids are acquired slowly, and gradually mixed with that proportion of air which they can dissolve or contain. The whole animal has grown up in this manner from the first vital atom of the embryo. For such reasons the pressure can occasion no change of shape by squeezing together the flexible parts; nor any obstruction by compressing the vessels or pores. We cannot say what would be felt by a man, were it possible that he could have been produced and grown up *in vacuo*, and then subjected to the compression. We even know that any sudden and considerable change of general pressure is very severely felt. Persons in a diving bell have been almost killed by letting them down or drawing them up too suddenly. In drawing up, the elastic matters within have suddenly swelled, and not finding an immediate escape have burst the vessels. Dr Halley experienced this, the blood gushing out from his ears by the expansion of air contained in the internal cavities of this organ, from which there are but very slender passages.

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A very important observation recurs here: the pressure of the atmosphere is variable. This was observed almost as soon as philosophers began to attend to the barometer. Pascal observed it in France, and Descartes observed it in Sweden in 1650. Mr Boyle and others observed it in England in 1656. And before this, observers, who took notice of the concomitancy of these changes of aerial pressure with the state of the atmosphere, remarked, that it was generally greatest in winter and in the night; and certainly most variable during winter and in the northern regions. Familiar now with the weight of the air, and considering it as the vehicle of the clouds and vapours, they noted with care the connection between the weather and the pressure of the air, and found that a great pressure of the air was generally accompanied with fair weather, and a diminution of it with rain and mists. Hence the barometer came to be considered as an index not only of the present state of the air's weight, but also as indicating by its variations changes of weather. It became a WEATHER-GLASS, and continued to be anxiously observed with this view. This is an important subject, and will afterwards be treated in some detail.

In the next place, we may conclude that the pressure of the air will be different in different places, according to their elevation above the surface of the ocean: for if air be an heavy fluid, it must press in some proportion according to its perpendicular height. If it be a homogeneous fluid of equal density and weight in all its parts, the mercury in the cistern of a barometer must be pressed precisely in proportion to the depth to which that cistern is immersed in it; and as this pressure is exactly measured by the height of the mercury in the tube, the height of the mercury in the Toricellian tube must be exactly proportional to the depth of the place of observation under the surface of the atmosphere.

The celebrated Descartes first entertained this thought (Epist. 67. of Pr. III.), and soon after him Pascal. His occupation in Paris not permitting him to try the justness of his conjecture, he requested Mr Perrier, a gentleman of Clermont in Auvergne, to make the experiment, by observing the height of the mercury at one and the same time at Clermont and on the top of a very high mountain in the neighbourhood. His letters to Mr Perrier in 1647 are still extant. Accordingly Mr Perrier, in September 1648, filled two equal tubes with mercury, and observed the heights of both to be the same, viz. $26\frac{7}{8}$ inches, in the garden of the convent of the Friars Minims, situated in the lowest part of Clermont. Leaving one of them there, and one of the fathers to observe it, he took the other to the top of Puy de Domme, which was elevated nearly 500 French fathoms above the garden. He found its height to be $23\frac{7}{8}$ inches. On his return to the town, in a place called *Font de l'Arbre*, 150 fathoms above the garden, he found it 25 inches; when he returned to the garden it was again $26\frac{7}{8}$, and the person set to watch the tube which had been left said that it had not varied the whole day. Thus a difference of elevation of 3000 French feet had occasioned a depression of $3\frac{1}{8}$ inches; from which it may be concluded, that $3\frac{1}{8}$ inches of mercury weighs as much as 3000 feet of air, and one-tenth of an inch of mercury as much as 96 feet of air. The next day he found, that taking the tube to the top of a steeple 120 feet high made a fall of one-sixth of an

inch. This gives 72 feet of air for one-tenth of an inch of mercury; but ill agreeing with the former experiment. But it is to be observed, that a very small error of observation of the barometer would correspond to a great difference of elevation, and also that the height of the mountain had not been measured with any precision. This has been since done (Mem. Acad. par. 1703), and found to be 529 French toises.

Pascal published an account of this great experiment (*Grande Exp. sur la Pesanteur de l'Air*), and it was quickly repeated in many places of the world. In 1653 it was repeated in England by Dr Power (Power's Exper. Phil.); and in Scotland, in 1661, by Mr Sinclair professor of philosophy in the university of Glasgow, who observed the barometer at Lanark, on the top of mount Tintock in Clydesdale, and on the top of Arthur's Seat at Edinburgh. He found a depression of two inches between Glasgow and the top of Tintock, three quarters of an inch between the bottom and top of Arthur's Seat, and $\frac{1}{8}$ of an inch at the cathedral of Glasgow on a height of 126 feet. See Sinclair's *Ars Nova et Magna Gravitatis et Levitatis*; Sturmii *Collegium Experimentale*, and Schotti *Technica Curiosa*.

Hence we may derive a method of measuring the heights of mountains. Having ascertained with great precision the elevation corresponding to a fall of one-tenth of an inch of mercury, which is nearly 90 feet, we have only to observe the length of the mercurial column at the top and bottom of the mountain, and to allow 90 feet for every tenth of an inch. Accordingly this method has been practised with great success: but it requires an attention to many things not yet considered; such as the change of density of the mercury by heat and cold; the changes of density of air, which are much more remarkable from the same causes; and above all, the changes of the density of air from its compressibility; a change immediately connected with or dependent on the very elevation we wish to measure. Of all these afterwards.

These observations give us the most accurate measure of the density of the air and its specific gravity. This is but vaguely though directly measured by weighing air in a bladder or vessel. The weight of a manageable quantity is so small, that a balance sufficiently ticklish to indicate even very sensible fractions of it is overloaded by the weight of the vessel which contains it, and ceases to be exact: and when we take Bernoulli's ingenious method of suspending it in water, we expose ourselves to great risk of error by the variation of the water's density. Also it must necessarily be humid air which we can examine in this way: but the proportion of an elevation in the atmosphere to the depression of the column of mercury or other fluid, by which we measure its pressure, gives us at once the proportion of this weight or their specific gravity. Thus since it is found that in such a state of pressure that the barometer stands at 30 inches, and the thermometer at 32° , 87 feet of rise produces one-tenth of an inch of fall in the barometer, the air and the mercury being both of the freezing temperature, we must conclude that mercury is 10,440 times heavier or denser than air. Then, by comparing mercury and water, we get $\frac{1}{857}$ nearly for the density of air relative to water: but this varies so much by heat and moisture, that it is useless to retain any thing more than a general notion of it; nor is it easy to determine

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whether this method, or that by actual weighing is preferable. It is extremely difficult to observe the height of the mercury in the barometer nearer than $\frac{1}{100}$ of an inch; and this will produce a difference of even five feet, or $\frac{1}{10}$ of the whole. Perhaps this is a greater proportion than the error in weighing.

45
And some knowledge of the height of the atmosphere here.

From the same experiments we also derive some knowledge of the height of the aerial covering which surrounds our globe. When we raise our barometer 87 feet above the surface of the sea, the mercury falls about one-tenth of an inch in the barometer: therefore if the barometer shows 30 inches at the sea-shore, we may expect that, by raising it 300 times 87 feet or 5 miles, the mercury in the tube will descend to the level of the cistern, and that this is the height of our atmosphere. But other appearances lead us to suppose a much greater height. Meteors are seen with us much higher than this, and which yet give undoubted indication of being supported by our air. There can be little doubt, too, that the visibility of the expanse above us is owing to the reflection of the sun's light by our air. Were the heavenly spaces perfectly transparent, we should no more see them than the purest water through which we see other objects; and we see *them* as we see water tinged with milk or other fæcule. Now it is easy to show, that the light which gives us what is called twilight must be reflected from the height of at least 50 miles; for we have it when the sun is depressed 18 degrees below our horizon.

46
Why this knowledge is not accurate.

A little attention to the constitution of our air will convince us, that the atmosphere must extend to a much greater height than 300 times 87 feet. We see from the most familiar facts that it is compressible; we can squeeze it in an ox-bladder. It is also heavy; pressing on the air in this bladder with a very great force, not less than 1500 pounds. We must therefore consider it as in a state of compression, existing in smaller room than it would assume if it were not compressed by the incumbent air. It must therefore be in a condition something resembling that of a quantity of fine carded wool thrown loosely into a deep pit; the lower strata carrying the weight of the upper strata, and being compressed by them; and so much the more compressed as they are further down, and only the upper stratum in its unconstrained and most expanded state. If we shall suppose this wool thrown in by a hundred weight at a time, it will be divided into strata of equal weights, but of unequal thickness; the lowest being the thinnest, and the superior strata gradually increasing in thickness. Now, suppose the pit filled with air, and reaching to the top of the atmosphere, the *weights* of all the strata above any horizontal plane in it is measured by the height of the mercury in the Toricellian tube placed in that plane; and one-tenth of an inch of mercury is just equal to the weight of the lowest stratum 87 feet thick: for on raising the tube 87 feet from the sea, the surface of the mercury will descend one-tenth of an inch. Raise the tube till the mercury fall another tenth: This stratum must be more than 87 feet thick; how much more we cannot tell, being ignorant of the law of the air's expansion. In order to make it fall a third tenth, we must raise it through a stratum still thicker; and so on continually.

All this is abundantly confirmed by the very first experiment made by the order and directions of Pascal: For by carrying the tube from the garden of the con-

vent to a place 150 fathoms higher, the mercury fell $1\frac{1}{2}$ inches, or 1,2917; which gives about 69 feet 8 inches of aerial stratum for $\frac{1}{10}$ of an inch of mercury; and by carrying it from thence to a place 350 fathoms higher, the mercury fell $1\frac{1}{2}$, or 1,9167 inches, which gives 109 feet 7 inches for $\frac{1}{10}$ of an inch of mercury. These experiments were not accurately made; for at that time the philosophers, though zealous, were but *strangers* in the science of experimenting, and novices in the art. But the results abundantly show this general truth, and they are completely confirmed by thousands of subsequent observations. It is evident from the whole tenor of them, that the strata of air decrease in density as we ascend through the atmosphere; but it remained to be discovered what is the force of this decrease, that is, the law of the air's expansion. Till this be done we can say nothing about the constitution of our atmosphere: we cannot tell in what manner it is fittest for raising and supporting the exhalations and vapours which are continually arising from the inhabited regions; not as an excrementitious waste, but to be supported, perhaps manufactured, in that vast laboratory of nature, and to be returned to us in beneficent showers. We cannot use our knowledge for the curious, and frequently useful, purpose of measuring the heights of mountains and taking the levels of extensive regions; in short, without an accurate knowledge of this, we can hardly acquire any acquaintance with those mechanical properties which distinguish air from those liquids which circulate here below.

Having therefore considered at some length the leading consequences of the air's fluidity and gravity, let *us* consider its compressibility with the same care; and then, combining the agency of both, we shall answer all the purposes of philosophy, discover the laws, explain the phenomena of nature, and improve art. We proceed therefore to consider a little the phenomena which indicate and characterise this other property of the air. All fluids are elastic and compressible as well as air; but in them the compressibility makes no figure, or does not interest us while we are considering their pressure, motions, and impulsions. But in air the compressibility and expansion draw our chief attention, and make it a proper representative of this class of fluids.

Nothing is more familiar than the compressibility of air. It is seen in a bladder filled with it, which we can *forcibly* squeeze into less room; it is seen in a syringe, of which we can push the plug farther and farther as we increase the pressure.

But these appearances bring into view another, and the most interesting, property of air, *viz.* its *elasticity*. When we have squeezed the air in the bladder or syringe into less room, we find that the force with which we *compressed* it is necessary to *keep it in this bulk*; and that if we cease to press it together, it will swell out and regain its natural dimensions. This distinguishes it essentially from such a body as a mass of flour, salt, or such like, which remain in the compressed state to which we reduce them.

There is therefore something which opposes the compression different from the simple impenetrability of the air: there is something that opposes mechanical force: there is something too which produces motion, not only resisting compression, but pushing back the compressing body, and communicating motion to it. As

an arrow is gradually accelerated by the bow-string pressing it forward, and at the moment of its discharge is brought to a state of rapid motion; so the ball from a pop-gun or wind-gun is gradually accelerated along the barrel by the pressure of the air during its expansion from its compressed state, and finally quits it with an accumulated velocity. These two motions are indications perfectly similar of the elasticity of the bow and of the air.

Thus it appears that air is heavy and elastic. It needs little consideration to convince us in a vague manner that it is fluid. The ease with which it is penetrated, and driven about in every direction, and the motion of it in pipes and channels, however crooked and intricate, intitle it to this character. But before we can proceed to deduce consequences from its fluidity, and to offer them as a true account of what will happen in these circumstances, it is necessary to exhibit some distinct and simple case, in which the characteristic mechanical property of a fluid is clearly and unequivocally observed in it. That property of fluids from which all the laws of hydrostatics and hydraulics are derived with strictest evidence is, that any pressure applied to any part of them is propagated through the whole mass in every direction; and that in consequence of this diffusion of pressure, any two external forces can be put in equilibrio by the interposition of a fluid, in the same way as they can be put in equilibrio by the intervention of any mechanical engine.

Let a close vessel ABC (fig. 7.), of any form, have two upright pipes EDC, GFB, inserted into any parts of its top, sides, or bottom, and let water be poured into them, so as to stand in equilibrio with the horizontal surfaces at E, D, G, F, and let Dd, Ff, be horizontal lines, it will be found that the height of the column E d is sensibly equal to that of the column G f. This is a fact universally observed in whatever way the pipes are inserted.

Now the surface of the water at D is undoubtedly pressed upwards with a force equal to a column of water, having its surface for its base, and Ed for its height; it is therefore prevented from rising by some opposite force. This can be nothing but the elasticity of the confined air pressing it down. The very same thing must be said of the surface at F; and thus there are two external pressures at D and F set in equilibrio by the interposition of air. The force exerted on the surface D, by the pressure of the column E d, is therefore propagated to the surface at F; and thus air has this characteristic mark of fluidity.

In this experiment the weight of the air is insensible when the vessel is of small size, and has no sensible share in the pressure reaching at D and F. But if the elevation of the point F above D is very great, the column E d will be observed sensibly to exceed the column G f. Thus if F be 70 feet higher than D, E d will be an inch longer than the column G f: for in this case there is reacting at D, not only the pressure propagated from F, but also the weight of a column of air, having the surface at D for its base and 70 feet high. This is equal to the weight of a column of water one inch high.

It is by this propagation of pressure, this fluidity, that the pellet is discharged from a child's pop-gun. It sticks fast in the muzzle; and he forces in another pellet at the other end, which he presses forward with the

runner, condensing the air between them, and thus propagating to the other pellet the pressure which he exerts, till the friction is overcome, and the pellet is discharged by the air expanding and following it.

There is a pretty philosophical plaything which illustrates this property of air in a very perspicuous manner, and which we shall afterwards have occasion to consider as converted into a most useful hydraulic machine. This is what is usually called *Hero's fountain*, having been invented by a Syracusan of that name. It consists of two vessels KLMN (fig. 8.), OPQR, which are close on all sides. A tube AB, having a funnel A-top, passes through the uppermost vessel without communicating with it, being soldered into its top and bottom. It also passes through the top of the under-vessel, where it is also soldered, and reaches almost to its bottom. This tube is open at both ends. There is another open tube ST, which is soldered into the top of the under-vessel and the bottom of the upper vessel, and reaches almost to its top. These two tubes serve also to support the upper vessel. A third tube GF is soldered into the top of the upper vessel, and reaches almost to its bottom. This tube is open at both ends, but the orifice G is very small. Now suppose the uppermost vessel filled with water to the height EN, Ee being its surface a little below T. Stop the orifice G with the finger, and pour in water at A. This will descend through AB, and compress the air in OQRP into less room. Suppose the water in the under vessel to have acquired the surface Cc, the air which formerly occupied the whole of the spaces OPQR and KLeE will now be contained in the spaces oPcC and KL eE; and its elasticity will be in equilibrio with the weight of the column of water, whose base is the surface Ee, and whose height is Ac. As this pressure is exerted in every part of the air, it will be exerted on the surface Ee of the water of the upper vessel; and if the pipe FG were continued upwards, the water would be supported in it to an height eH above Ee, equal to Ac. Therefore if the finger be now taken from off the orifice G, the water will spout up to the same height as if it had been immediately forced out by a column of water Ac without the intervention of the air, that is, nearly to H. If instead of the funnel at A, the vessel have a brim which will cause the water discharged at G to run down the pipe AB, this fountain will play till all the water in the upper vessel is expended. The operation of this second fountain will be better understood from fig. 9. which an intelligent reader will see is perfectly equivalent to fig. 8. A very powerful engine for raising water upon this principle has long been employed in the Hungarian mines; where the pipe AB is about 200 feet high, and the pipe FG about 120; and the condensation is made in the upper vessel, and communicated to the lower, at the bottom of the mine, by a long pipe. See *WATER-WORKS*.

We may now apply to air all the laws of hydrostatics and hydraulics, in perfect confidence that their legitimate consequences will be observed in all its situations. We shall in future substitute, in place of any force acting on a surface of air, a column of water, mercury, or any other fluid whose weight is equal to this force: and as we know distinctly from theory what will be the consequences of this hydrostatic pressure, we shall determine *a priori* the phenomena in air; and in cases

where theory does not enable us to say with precision what is the effect of this pressure, experience informs us in the case of water, and analogy enables us to transfer this to air. We shall find this of great service in some cases, which otherwise are almost desperate in the present state of our knowledge.

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From such familiar and simple observations and experiments, the fluidity, the heaviness, and elasticity, are discovered of the substance with which we are surrounded, and which we call *air*. But to understand these properties, and completely to explain their numerous and important consequences, we must call in the aid of more refined observations and experiments which even this scanty knowledge of them enables us to make; we must contrive some methods of producing with precision any degree of condensation or rarefaction, of employing or excluding the gravitating pressure of air, and of modifying at pleasure the action of all its mechanical properties.

57
A method
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ing the air
by

Nothing can be more obvious than a method of compressing a quantity of air to any degree. Take a cylinder or prismatic tube *AB* (fig. 10.) shut at one end, and fit it with a piston or plug *C*, so nicely that no air can pass by its sides. This will be best done in a cylindric tube by a turned stopper, covered with oiled leather, and fitted with a long handle *CD*. When this is thrust down, the air which formerly occupied the whole capacity of the tube is condensed into less room. The force necessary to produce any degree of compression may be concluded from the weight necessary for pushing down the plug to any depth. But this instrument leaves us little opportunity of making interesting experiments on or in this condensed air; and the force required to make any degree of compression cannot be measured with much accuracy; because the piston must be very close, and have great friction, in order to be sufficiently tight: And as the compression is increased, the leather is more squeezed to the side of the tube; and the proportion of the external force, which is employed merely to overcome this variable and uncertain friction, cannot be ascertained with any tolerable precision. To get rid of these imperfections, the following addition may be made to the instrument, which then becomes what is called the *condensing syringe*.

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The end of the syringe is perforated with a very small hole *ef*; and being externally turned to a small cylinder, a narrow slip of bladder, or of thin leather, soaked in a mixture of oil and tallow, must be tied over the hole. Now let us suppose the piston pushed down to the bottom of the barrel to which it applies close; when it is drawn up to the top, it leaves a void behind, and the weight of the external air presses on the slip of bladder, which therefore claps close to the brass, and thus performs the part of a valve, and keeps it close so that no air can enter. But the piston having reached the top of the barrel, a hole *F* in the side of it is just below the piston, and the air rushes through this hole and fills the barrel. Now push the piston down again, it immediately passes the hole *F*, and no air escapes through it; it therefore forces open the valve at *f*, and escapes while the piston moves to the bottom.

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Its vessel or
receiver.

Now let *E* be any vessel, such as a glass bottle, having its mouth furnished with a brass cap firmly cemented to it, having a hollow screw which fits a solid screw *p*, turned on the cylindric nozzle of the syringe.

Screw the syringe into this cap, and it is evident that the air forced out of the syringe will be accumulated in this vessel: for upon drawing up the piston the valve *f* always shuts by the elasticity or expanding force of the air in *E*; and on pushing it down again, the valve will open as soon as the piston has got so far down that the air in the lower part of the barrel is more powerful than the air already in the vessel. Thus at every stroke an additional barrellful of air will be forced into the vessel *E*; and it will be found, that after every stroke the piston must be farther pushed down before the valve will open. It cannot open till the pressure arising from the elasticity of the air condensed in the barrel is superior to the elasticity of the air condensed in the vessel; that is, till the condensation of the first, or its density, is somewhat greater than that of the last, in order to overcome the straining of the valve on the hole and the sticking occasioned by the clammy matter employed to make it air-tight.

Sometimes the syringe is constructed with a valve in the piston. This piston, instead of being of one piece and solid, consists of two pieces perforated. The upper part *iknm* is connected with the rod or handle, and has its lower part turned down to a small cylinder, which is screwed into the lower part *klon*; and has a perforation *gb* going up in the axis, and terminating in a hole *b* in one side of the rod, a piece of oiled leather is strained across the hole *g*. When the piston is drawn up and a void left below it, the weight of the external air forces it through the hole *bg*, opens the valve *g*, and fills the barrel. Then, on pushing down the piston, the air being squeezed into less room, presses on the valve *g*, shuts it; and none escaping through the piston, it is gradually condensed as the piston descends till it opens the valve *f*, and is added to that already accumulated in the vessel *E*.

Having in this manner forced a quantity of air into the vessel *E*, we can make many experiments in it in this state of condensation. We are chiefly concerned at present with the effect which this produces on its elasticity. We see this to be greatly increased; for we find more and more force required for introducing every successive barrellful. When the syringe is unscrewed, we see the air rush out with great violence, and every indication of great expanding force. If the syringe be connected with the vessel *E* in the same manner as the syringe in n^o 17, viz. by interposing a stopcock *B* between them (see fig. 3.), and if this stopcock have a pipe at its extremity, reaching near to the bottom of the vessel, which is previously half filled with water, we can observe distinctly when the elasticity of the air in the syringe exceeds that of the air in the receiver: for the piston must be pushed down a certain length before the air from the syringe bubbles up through the water, and the piston must be farther down at each successive stroke before this appearance is observed: When the air has thus been accumulated in the receiver, it presses the sides of it outward, and will burst it if not strong enough. It also presses on the surface of the water; and if we now shut the cock, unscrew the syringe, and open the cock again, the air will force the water through the pipe with great velocity, causing it to rise in a beautiful jet. When a metal-receiver is used, the condensation may be pushed to a great length, and the jet will then rise to a great height; which gradually

dually diminishes as the water is expended and room given to the air to expand itself. See the figure.

We judge of the condensation of air in the vessel E by the number of strokes and the proportion of the capacity of the syringe to that of the vessel. Suppose the first to be one-tenth of the last; then we know, that after 10 strokes the quantity of air in the vessel is doubled, and therefore its density double, and so on after any number of strokes. Let the capacity of the syringe (when the piston is drawn to the top) be a , and that of the vessel be b , and the number of strokes be n , the density of air in the vessel will be $\frac{b+na}{b}$, or $1 + \frac{na}{b}$.

But this is on the supposition that the piston accurately fills the barrel, the bottom of the one applying close to that of the other, and that no force is necessary for opening either of the valves: but the first cannot be insured, and the last is very far from being true. In the construction now described, it will require at least one twentieth-part of the ordinary pressure of the air to open the piston valve: therefore the air which gets in will want at least this proportion of its complete elasticity; and there is always a similar part of the elasticity employed in opening the nozzle valve. The condensation therefore is never nearly equal to what is here determined.

It is accurately enough measured by a gage fitted to the instrument. A glass tube GH of a cylindric bore, and close at the end, is screwed into the side of the cap on the mouth of the vessel E. A small drop of water or mercury is taken into this tube by warming it a little in the hand, which expands the contained air, so that when the open end is dipped into water, and the whole allowed to cool, the water advances a little into the tube. The tube is furnished with a scale divided into small equal parts, numbered from the close end of the tube. Since this tube communicates with the vessel, it is evident that the condensation will force the water along the tube, acting like a piston on the air beyond it, and the air in the tube and vessel will always be of one density. Suppose the number at which the drop stands before the condensation is made to be c , and that it stands at d when the condensation has attained the degree required, the density of the air in the remote end of the gage, and consequently in the vessel, will be $\frac{c}{d}$.

Sometimes there is used any bit of tube close at one end, having a drop of water in it, simply laid into the vessel E, and furnished or not with a scale: but this can only be used with glass vessels, and these are too weak to resist the pressure arising from great condensation. In such experiments metalline vessels are used, fitted with a variety of apparatus for different experiments. Some of these will be occasionally mentioned afterwards.

It must be observed in this place, that very great condensations require great force, and therefore small syringes. It is therefore convenient to have them of various sizes, and to begin with those of a larger diameter, which operate more quickly; and when the condensation becomes fatiguing, to change the syringe for a smaller.

For this reason, and in general to make the condensing apparatus more convenient, it is proper to have a stop-cock interposed between the syringe and the vessel, or as it is usually called the receiver. This consists of a brass pipe, which has a well-ground cock in its middle, and has a hollow screw at one end, which receives the nozzle screw of the syringe, and a solid screw at the other end, which fits the screw of the receiver. See fig. 3.

By these gages, or contrivances similar to them, we have been able to ascertain very great degrees of condensation in the course of some experiments. Dr Hales found, that when dry wood was put into a strong vessel, which it almost filled, and the remainder was filled with water, the swelling of the wood, occasioned by its imbibition of water, condensed the air of his gage into the thousandth of its original bulk. He found that pease treated in the same way generated elastic air, which pressing on the air in the gage condensed it into the fifteen hundredth part of its bulk. This is the greatest condensation that has been ascertained with precision, although in other experiments it has certainly been carried much farther; but the precise degree could not be ascertained.

The only use to be made of this observation at present is, that since we have been able to exhibit air in a density a thousand times greater than the ordinary density of the air we breathe, it cannot, as some imagine, be only a different form of water; for in this state it is as dense or denser than water, and yet retains its great expansibility.

Another important observation is, that in every state of density in which we find it, it retains its perfect fluidity, transmitting all pressures which are applied to it with undiminished force, as appears by the equality constantly observed between the opposing columns of water or other fluid by which it is compressed, and by the facility with which all motions are performed in it in the most compressed states in which we can make observations of this kind. This fact is totally incompatible with the opinion of those who ascribe the elasticity of air to the springy ramified structure of its particles, touching each other like so many pieces of sponge or foot-balls. A collection of such particles might indeed be pervaded by solid bodies with considerable ease, if they were merely touching each other, and not subjected to any external pressure. But the moment such pressure is exerted, and the assemblage squeezed into a smaller space, each presses on its adjoining particles: they are individually compressed, flattened in their touching surfaces, and before the density is doubled they are squeezed into the form of perfect cubes, and compose a mass, which may indeed propagate pressure from one place to another in an imperfect manner, and with great diminution of its intensity, but will no more be fluid than a mass of soft clay. It will be of use to keep this observation in mind.

We have seen that air is heavy and compressible, and might now proceed to deduce in order the explanation of the appearances consequent on each of these properties. But, as has been already observed, the elasticity of air modifies the effects of its gravity so remarkably, that they would be imperfectly understood if both qualities were not combined in our consideration of either. At any rate, some farther consequences of its elasticity

ticity must be considered, before we understand the means of varying at pleasure the effects of its gravity.

72
Its great
expansibili-
ty

Since air is heavy, the lower strata of a mass of air must support the upper; and, being compressible, they must be condensed by their weight. In this state of compression the elasticity of the lower strata of air acts in opposition to the weight of the incumbent air, and balances it. There is no reason which should make us suppose that its expanding force belongs to it only when in such a state of compression. It is more probable, that, if we could free it from this pressure, the air would expand itself into still greater bulk. This is most distinctly seen in the following experiment.

73
Proved by
experiment.

Into the cylindric jar ABCD (fig. 11.), which has a small hole in its bottom, and is furnished with an air-tight piston E, put a small flaccid bladder, having its mouth tied tight with a string. Having pushed the piston near to the bottom, and noticed the state of the bladder, stop up the hole in the bottom of the jar with the finger, and draw up the piston, which will require a considerable force. You will observe the bladder swell out, as if air had been blown into it; and it will again collapse on allowing the piston to descend. Nothing can be more unexceptionable than the conclusion from this experiment, that ordinary air is in a state of compression, and that its elasticity is not limited to this state. The bladder being flaccid, shows that the included air is in the same state with the air which surrounds it; and the same must be affirmed of it while it swells but still remains flaccid. We must conclude, that the whole air within the vessel expands, and continues to fill it, when its capacity has been enlarged. And since this is observed to go on as long as we give it more room, we conclude, that by such experiments we have not yet given it so much room as it can occupy.

74
Attempts
to discover
the limits
of this ex-
pansion by

It was a natural object of curiosity to discover the limits of this expansion; to know what was the natural unconstrained bulk of a quantity of air, beyond which it would not expand though all external compressing force were removed. Accordingly philosophers constructed instruments for *rarefying* the air. The common water-pump had been long familiar, and appeared very proper for this purpose. The most obvious is the following.

75
A syringe;

Let the barrel of the syringe AB (fig. 12.) communicate with the vessel V, with a stopcock C between them. Let it communicate with the external air by another orifice D, in any convenient situation, also furnished with a stopcock. Let this syringe have a piston very accurately fitted to it so as to touch the bottom all over when pushed down, and have no vacancy about the sides.

76
From the
operation
of which

Now suppose the piston at the bottom, the cock C open, and the cock D shut, draw the piston to the top. The air which filled the vessel V will expand so as to fill both that vessel and the barrel AB; and as no reason can be given to the contrary, we must suppose that the air will be uniformly diffused through both. Calling V and B the capacity of the vessel and barrel, it is plain that the bulk of the air will now be V+B; and since the quantity of matter remains the same, and the density of a fluid is as its quantity of matter directly and its bulk inversely, the density of the expanded air

will be $\frac{V}{V+B}$, the density of common air being 1: for

$$V+B:V::1:\frac{V}{V+B}.$$

The piston requires force to raise it, and it is raised in opposition to the pressure of the incumbent atmosphere; for this had formerly been balanced by the elasticity of the common air: and we conclude from the fact, that force is required to raise the piston, that the air, elasticity of the expanded air is less than that of air in its ordinary state; and an accurate observation of the force necessary to raise it would show how much the elasticity is diminished. When therefore the piston is let go, it will descend as long as the pressure of the atmosphere exceeds the elasticity of the air in the barrel; that is, till the air in the barrel is in a state of ordinary density. To put it further down will require force, because the air must be compressed in the barrel; but if we now open the cock D, the air will be expelled through it, and the piston will reach the bottom.

Now shut the *discharging cock* D, and open the cock C, and draw up the piston. The air which occupied

the space V, with the density $\frac{V}{V+B}$, will now occupy the space V+B, if it expands so far. To have its density D, say, As its present bulk V+B is to its former bulk V, so is its former density $\frac{V}{V+B}$ to its new density; which will therefore be $\frac{V \times V}{V+B \times V+B}$,

$$\text{or } \left[\frac{V}{V+B} \right]^2.$$

It is evident, that if the air continues to expand, the density of the air in the vessel after the third drawing up of the piston will be $\left[\frac{V}{V+B} \right]^3$, after the fourth

it will be $\left[\frac{V}{V+B} \right]^4$, and after any number of strokes n will be $\left[\frac{V}{V+B} \right]^n$. Thus, if the vessel is four times as

large as the barrel, the density after the fifth stroke will be $\frac{1}{9 \frac{1}{4}}$, nearly $\frac{1}{10}$ of its ordinary density.

On the other hand, the number n of strokes necessary for reducing air to the density D is

$$\frac{\text{Log } D}{\text{Log } V - \text{Log } (V+B)}.$$

Thus we see that this instrument can never abstract the whole air in consequence of its expansion, but only rarefy it continually as long as it continues to expand; nay, there is a limit beyond which the rarefaction cannot go. When the piston has reached the bottom, there remains a small space between it and the cock C filled with common air. When the piston is drawn up, this small quantity of air expands, and also a similar quantity in the neck of the other cock; and no air will come out of the receiver V till the expanded air in the barrel is of a smaller density than the air in the receiver. This circumstance evidently directs us to make these two spaces as small as possible, or by some contrivance

contrivance to fill them up altogether. Perhaps this may be done effectually in the following manner.

Let BE (fig. 13.) represent the bottom of the barrel, and let the circle HKI be the section of the key of the cock, of a large diameter, and place it as near to the barrel as can be. Let this communicate with the barrel by means of an hole FG widening upwards, as the frustum of a hollow obtuse cone. Let the bottom of the piston *b f b g e* be shaped so as to fit the bottom of the barrel and this hole exactly. Let the cock be pierced with two holes. One of them, HI, passes perpendicularly through its axis, and forms the communication between the receiver and barrel. The other hole, KL, has one extremity K on the same circumference with H, so that when the key is turned a fourth part round, K will come into the place of H: but this hole is pierced obliquely into the key, and thus keeps clear of the hole HI. It goes no further than the axis, where it communicates with a hole bored along the axis and terminating at its extremity. This hole forms the communication with the external air, and serves for discharging the air in the barrel. (A side view of the key is seen in fig. 14.) Fig. 12. shows the position of the cock while the piston is moving upwards, and fig. 14. shows its position while the piston is moving downwards. When the piston has reached the bottom, the conical piece *f b g e* of the piston, which may be of firm leather, fills the hole FHG, and therefore completely expels the air from the barrel. The canal KL of the cock contains air of the common density; but this is turned aside into the position KL (fig. 13.), while the piston is still touching the cock. It cannot expand into the barrel during the ascent of the piston. In place of it the perforation HLI comes under the piston, filled with air that had been turned aside with it when the piston was at the top of the barrel, and therefore of the same density with the air of the receiver. It appears therefore that there is no limit to the rarefaction as long as the air will expand.

This instrument is called an EXHAUSTING SYRINGE. It is more generally made in another form, which is much less expensive, and more convenient in its use. Instead of being furnished with cocks for establishing the communications and shutting them, as is necessary, it has valves like those of the condensing syringe, but opening in the opposite direction. It is thus made:

The pipe of communication or conduit MN (fig. 15.), has a male screw in its extremity, and over this is tied a slip of bladder or leather M. The lower half of the piston has also a male screw on it, covered at the end with a slip of bladder O. This is screwed into the upper half of the piston, which is pierced with a hole H coming out of the side of the rod.

Now suppose the syringe screwed to the conducting pipe, and that screwed into the receiver V, and the piston at the bottom of the barrel. When the piston is drawn up, the pressure of the external air shuts the valve O, and a void is left below the piston: there is therefore no pressure on the upper side of the valve M to balance the elasticity of the air in the receiver which formerly balanced the weight of the atmosphere. The air therefore in the receiver lifts this valve, and distributes itself between the vessel and the barrel; so that

when the piston has reached the top the density of the air in both receiver and barrel is as before $\frac{V}{V+B}$.

When the piston is let go it descends, because the elasticity of the expanded air is not a balance for the pressure of the atmosphere, which therefore presses down the piston with the difference, keeping the piston-valve shut all the while. At the same time the valve M also shuts: for it was opened by the prevailing elasticity of the air in the receiver, and while it is open the two airs have equal density and elasticity; but the moment the piston descends, the capacity of the barrel is diminished, the elasticity of its air increases by collapsing, and now prevailing over that of the air in the receiver shuts the valve M.

When it has arrived at such a part of the barrel that the air in it is of the density of the external air, there is no force to push it farther down; the hand must therefore press it. This attempts to condense the air in the barrel, and therefore increases its elasticity; so that it lifts the valve O and escapes, and the piston gets to the bottom. When drawn up again, greater force is required than the last time, because the elasticity of the included air is less than in the former stroke. The piston rises further before the valve M is lifted up, and when it has reached the top of the barrel the density of the included air is $\frac{V}{V+B}$. The piston, when let go,

will descend further than it did before ere the piston-valve open, and the pressure of the hand will again push it to the bottom, all the air escaping through O. The rarefaction will go on at every successive stroke in the same manner as with the other syringe.

This syringe is evidently more easy in its use, requiring no attendance to the cocks to open and shut them at the proper times. On this account this construction of an exhausting syringe is much more generally used.

But it is greatly inferior to the syringe with cocks with respect to its power of rarefaction. Its operation is greatly limited. It is evident that no air will come out of the receiver unless its elasticity exceed that of the air in the barrel by a difference able to lift up the valve M. A piece of oiled leather tied across this hole can hardly be made tight and certain of clapping to the hole without some small straining, which must therefore be overcome. It must be very gentle indeed not to require a force equal to the weight of two inches of water, and this is equal to about the 200th part of the whole elasticity of the ordinary air; and therefore this syringe, for this reason alone, cannot rarefy air above 200 times, even though air were capable of an indefinite expansion. In like manner the valve O cannot be raised without a similar prevalence of the elasticity of the air in the barrel above the weight of the atmosphere. These causes united, make it difficult to rarefy the air more than 100 times, and very few such syringes will rarefy it more than 50 times; whereas the syringe with cocks, when new and in good order, will rarefy it 1000 times.

But, on the other hand, syringes with cocks are much more expensive, especially when furnished with syringe, apparatus for opening and shutting the cocks. They are more difficult to make equally tight, and (which is more liable to go out of order.

Air-pump. the greatest objection) do not remain long in good order. The cocks, by so frequently opening and shutting, grow loose, and allow the air to escape. No method has been found of preventing this. They must be ground tight by means of emery or other cutting powders. Some of these unavoidably stick in the metal, and continue to wear it down. For this reason philosophers, and the makers of philosophical instruments, have turned their chief attention to the improvement of the syringe with valves. We have been thus minute in the account of the operation of rarefaction, that the reader may better understand the value of these improvements, and in general the operation of the principal pneumatic engines.

Of the AIR-PUMP.

91
Invention
of the air-
pump by
Guericke.

An AIR-PUMP is nothing but an exhausting syringe accommodated to a variety of experiments. It was first invented by Otto Guericke, a gentleman of Magdeburgh in Germany, about the year 1654. We trust that it will not be unacceptable to our readers to see this instrument, which now makes a principal article in a philosophical apparatus, in its first form, and to trace it through its successive steps to its present state of improvement.

Guericke, indifferent about the solitary possession of an invention which gave entertainment to numbers who came to see his wonderful experiments, gave a minute description of all his pneumatic apparatus to Gaspar Schottus professor of mathematics at Wirtemberg, who immediately published it with the author's consent, with an account of some of its performances, first in 1657, in his *Mechanica Hydraulico-pneumatica*; and then in his *Technica Curiosa*, in 1664, a curious collection of all the wonderful performances of art which he collected by a correspondence over all Europe.

92
Construc-
tion of his
pump.

Otto Guericke's air-pump consists of a glass receiver A (fig. 16.), of a form nearly spherical, fitted up with a brass cap and cock B. The nozzle of the cap was fixed to a syringe CDE, also of brass, bent at D into half a right angle. This had a valve at D, opening from the receiver into the syringe, and shutting when pressed in the opposite direction. In the upper side of the syringe there is another valve F, opening from the syringe into the external air, and shutting when pressed inwards. The piston had no valve. The syringe, the cock B, and the joint of the tube, were immersed in a cistern filled with water. From this description it is easy to understand the operation of the instrument. When the piston was drawn up from the bottom of the syringe, the valve F was kept shut by the pressure of the external air, and the valve D opened by the elasticity of the air in the receiver. When it was pushed down again, the valve D immediately shut by the superior elasticity of the air in the syringe; and when this was sufficiently compressed, it opened the valve F, and was discharged. It was immersed in water, that no air might find its way through the joints or cocks.

93
Its imper-
fections.

It would seem that this machine was not very perfect, for Guericke says that it took several hours to produce an evacuation of a moderate-sized vessel; but he says, that when it was in good order, the rarefaction (for he acknowledges that it was not, nor could be, a complete evacuation) was so great, that when the cock

was opened, and water admitted, it filled the receiver Air-pu so as sometimes to leave no more than the bulk of a pea filled with air. This is a little surprising; for if the valve F be placed as far from the bottom of the syringe as in Schottus's figure, it would appear that the rarefaction could not be greater than what must arise from the air in DF expanding till it filled the whole syringe: because as soon as the piston in its descent passes F it can discharge no more air, but must compress it between F and the bottom, to be expanded again when the piston is drawn up. It is probable that the piston was not very tight, but that on pressing it down it allowed the air to pass it; and the water in which the whole was immersed prevented the return of the air when it was drawn up again: and this accounts for the great time necessary for producing the desired rarefaction.

Guericke, being a gentleman of fortune, spared no expence, and added a part to the machine, which saved his numerous visitants the trouble of hours attendance before they could see the curious experiments with the rarefied air. He made a large copper vessel G (fig. 17.), having a pipe and cock below, which passed through the floor of the chamber into an under apartment, where it was joined to the syringe immersed in the cistern of water, and worked by a lever. The upper part of the vessel terminated in a pipe, furnished with a stopcock H, surrounded with a small brim to hold water for preventing the ingress of air. On the top was another cap I, also filled with water, to protect the junction of the pipes with the receiver K. This great vessel was always kept exhausted, and workmen attended below. When experiments were to be performed in the receiver K, it was set on the top of the great vessel, and the cock H was opened. The air in K immediately diffused itself equally between the two vessels, and was so much more rarefied as the receiver K was smaller than the vessel G. When this rarefaction was not sufficient, the attendants below immediately worked the pump.

These particulars deserve to be recorded, as they show the inventive genius of this celebrated philosopher, and because they are useful even in the present advanced state of the study. Guericke's method of excluding air from all the joints of his apparatus, by immersing these joints in water, is the only method that has to this day been found effectual; and there frequently occur experiments where this exclusion for a long time is absolutely necessary. In such cases it is necessary to construct little cups or cisterns at every joint, and to fill them with water or oil. In a letter to Schottus, 1662-3, he describes very ingenious contrivances for producing complete rarefaction after the elasticity of the remaining air has been so far diminished that it is not able to open the valves. He opens the exhausting valves by a plug, which is pushed in by the hand; and the discharging valve is opened by a small pump placed on its outside, so that it opens into a void instead of opening against the pressure of the atmosphere. (See *Schotti Technica Curiosa*, p. 68, 70.) These contrivances have been lately added to air-pumps by Haas and Hurter as new inventions.

It must be acknowledged, that the application of the pump or syringe to the exhaustion of air was a very obvious thought on the principle exhibited in n^o 17. and in this way it was also employed by Guericke, who first filled the receiver with water, and then applied the syringe. But this was by no means either his object or his

his principle. His object was not solely to procure a vessel void of air, but to exhaust the air which was already in it; and his principle was the power which he suspected to be in air of expanding itself into a greater space when the force was removed which he supposed to compress it. He expressly says (*Traët. de Experimentis Magdeburgicis, et in Epist. ad Schottum*), that the contrivance occurred to him accidentally when occupied with experiments in the Toricellian tube, in which he found that the air would really expand, and completely fill a much larger space than what it usually occupied, and that he had found no limits to the expansion, evincing this by facts which we shall perfectly understand by and by. This was a doctrine quite new, and required a philosophical mind to view it in a general and systematic manner; and it must be owned that his manner of treating the subject is equally remarkable for ingenuity and for modesty. (*Epist. ad Schottum.*)

His doctrine and his machine were soon spread over Europe. It was the age of literary ardour and philosophical curiosity; and it is most pleasant to us, who, standing on the shoulders of our predecessors, can see far around us, to observe the eagerness with which every new, and to us frivolous, experiment was repeated and canvassed. The worshippers of Aristotle were daily receiving severe mortifications from the experimenters, or empirics as they affected to call them, and they exerted themselves strenuously in support of his now tottering cause. This contributed to the rapid propagation of every discovery; and it was a most profitable and respectable business to go through the chief cities of Germany and France exhibiting philosophical experiments.

About this time the foundations of the Royal Society of London were laid. Mr Boyle, Mr Wren, Lord Brouncker, Dr Wallis, and other curious gentlemen, held meetings at Oxford, in which were received accounts of whatever was doing in the study of nature; and many experiments were exhibited. The researches of Galileo, Toricelli, and Pascal concerning the pressure of the air, greatly engaged their attention, and many additions were made to their discoveries. Mr Boyle, the most ardent and successful studier of nature, had the principal share in these improvements, his inquisitive mind being aided by an opulent fortune. In a letter to his nephew Lord Dungarvon, he says that he had made many attempts to see the appearances exhibited by bodies freed from the pressure of the air. He had made Toricellian tubes, having a small vessel a-top, into which he put some bodies before filling the tubes with mercury; so that when the tube was set upright, and the mercury run out, the bodies were in *vacuo*. He had also abstracted the water from a vessel, by a small pump, by means of its weight, in the manner described in n^o 17, having previously put bodies into the vessel along with the water. But all these ways were very troublesome and imperfect. He was delighted when he learned from Schottus's first publication, that Counsellor Guericke had effected this by the expansive power of the air; and immediately set about constructing a machine from his own ideas, no description of Guericke's being then published.

It consisted of a receiver A (fig. 18.), furnished with a stopcock B, and syringe CD placed in a vertical position below the receiver. Its valve C was in its bottom, close adjoining to the entry of the pipe of com-

munication; and the hole by which the air issued was farther secured by a plug which could be removed. The piston was moved by a wheel and rackwork. The receiver of Guericke's pump was but ill adapted for any considerable variety of experiments; and accordingly very few were made in it. Mr Boyle's receiver had a large opening EF, with a strong glass margin. To this was fitted a strong brass cap, pierced with a hole G in its middle, to which was fitted a plug ground into it, and shaped like the key of a cock. The extremity of this key was furnished with a screw, to which could be affixed a hook, or a variety of pieces for supporting what was to be examined in the receiver, or for producing various motions within it, without admitting the air. This was farther guarded against by means of oil poured round the key, where it was retained by the hollow cup-like form of the cover. With all these precautions, however, Mr Boyle ingeniously confesses, that it was but seldom, and with great difficulty, that he could produce an extreme degree of rarefaction; and it appears by Guericke's letter to Schottus, that in this respect the Magdeburgh machine had the advantage. But most of Boyle's very interesting experiments did not require this extreme rarefaction; and the variety of them, and their philosophic importance, compensated for this defect, and soon eclipsed the fame of the inventor to such a degree, that the state of air in the receiver was generally denominated the *vacuum Boyleanum*, and the air-pump was called *machina Boyleana*. It does not appear that Guericke was at all solicitous to maintain his claim to priority or invention. He appears to have been of a truly noble and philosophical mind, aiming at nothing but the advancement of science.

Mr Boyle found, that to make a vessel air-tight, it was sufficient to place a piece of wet or oiled leather on its brim, and to lay a flat plate of metal upon this. The pressure of the external air squeezed the two solid bodies so hard together, that the soft leather effectually excluded it. This enabled him to render the whole machine incomparably more convenient for a variety of experiments. He caused the conduit-pipe to terminate in a flat plate which he covered with leather, and on this he set the glass ball or receiver, which had both its upper and lower brim ground flat. He covered the upper orifice in like manner with a piece of oiled leather and a flat plate, having cocks and a variety of other perforations and contrivances suited to his purposes. This he found infinitely more expeditious, and also tighter, than the clammy cements which he had formerly used for securing the joints.

He was now assisted by Dr Hooke, the most ingenious and inventive mechanic that the world has ever seen. This person made a great improvement on the air-pump, by applying two syringes whose piston-rods were worked by the same wheel, as in fig. 20, n^o 1, and putting valves in the pistons in the same manner as in the piston of a common pump. This evidently doubled the expedition of the pump's operation: but it also greatly diminished the labour of pumping; for it must be observed, that the piston H must be drawn up against the pressure of the external air, and when the rarefaction is nearly perfect this requires a force of nearly 15 pounds for every inch of the area of the piston. Now when one piston H is at the bottom of the barrel, the other K is at

N

the

Air-pump.

98
His air-pump.99
His contrivances to make air-vessels tight.100
Dr Hooke's improvement of Boyle's air-pump

Air-pump.

the top of the barrel, and the air below K is equally rare with that in the receiver. Therefore the pressure of the external air on the piston K is nearly equal to that on the piston H. Both, therefore, are acting in opposite directions on the wheel which gave them motion; and the force necessary for raising H is only the difference between the elasticity of the air in the barrel H and that of the air in the barrel K. This is very small in the beginning of the stroke, but gradually increases as the piston K descends, and becomes equal to the whole excess of the air's pressure above the elasticity of the remaining air of the receiver when the air at K of the natural density begins to open the piston valves. An accurate attention to the circumstances will show us that the force requisite for working the pump is greatest at first, and gradually diminishes as the rarefaction advances; and when this is nearly complete, hardly any more force is required than what is necessary for overcoming the friction of the pistons, except during the discharge of the air at the end of each stroke.

101
Generally
adopted.

This is therefore the form of the air-pump which is most generally used all over Europe. Some traces of national prepossession remain. In Germany, air-pumps are frequently made after the original model of Guericke's (Wolff Cyclomathesis); and the French generally use the pump made by Papin, though extremely awkward. We shall give a description of Boyle's air-pump as finally improved by Hawkesbee, which, with some small accommodations to particular views, still remains the most approved form.

102
Hawkes-
bee's im-
provements
Plate
CCCCI.

Here follows the description from Desaguliers.

It consists of two brass barrels *aa*, *aa* (fig. 19.), 12 inches high and 2 wide. The pistons are raised and depressed by turning the winch *bb*. This is fastened to an axis passing through a strong toothed wheel, which lays hold of the teeth of the racks *cccc*. Then the one is raised while the other is depressed; by which means the valves, which are made of limber bladder, fixed in the upper part of each piston, as well as in the openings into the bottom of the barrels, perform their office of discharging the air from the barrels, and admitting into them the air from the receiver to be afterwards discharged; and when the receiver comes to be pretty well exhausted of its air, the pressure of the atmosphere in the descending piston is nearly so great, that the power required to raise the other is little more than is necessary for overcoming the friction of the piston, which renders this pump preferable to all others, which require more force to work them as the rarefaction of the air in the receiver advances.

103
Barrels.

The barrels are set in a brass dish about two inches deep, filled with water or oil to prevent the insinuation of air. The barrels are screwed tight down by the nuts *ee*, *ee*, which force the frontispiece *ff* down on them, through which the two pillars *gg*, *gg* pass.

104
Brass pipe,
&c.

From between the barrels rises a slender brass pipe *hh*, communicating with each by a perforation in the transverse piece of brass on which they stand. The upper end of this pipe communicates with another perforated piece of brass, which screws on underneath the plate *iii*, of ten inches diameter, and surrounded with a brass rim to prevent the shedding of water used in some experiments. This piece of brass has three branches: 1st, An horizontal one communicating with the conduit-

pipe *hh*. 2. An upright one screwed into the middle Air-pump of the pump-plate, and terminating in a small pipe *k*, rising about an inch above it. 3d, Is a perpendicular one, looking downwards in the continuation of the pipe *k*, and having a hollow screw in its end receiving the brass cap of the gage-pipe *llll*, which is of glass, 34 inches long, and immersed in a glass cistern *mm* filled with mercury. This is covered a-top with a cork float, carrying the weight of a light wooden scale divided into inches, which are numbered from the surface of the mercury in the cistern. This scale will therefore rise and fall with the mercury in the cistern, and indicate the true elevation of that in the tube.

There is a stopcock immediately above the insertion of the gage-pipe, by which its communication may be cut off. There is another at *n*, by which a communication is opened with the external air for allowing its readmission; and there is sometimes another immediately within the insertion of the conduct-pipe for cutting off the communication between the receiver and the pump. This is particularly useful when the rarefaction is to be continued long, as there are by these means fewer chances of the insinuation of air by the many joints.

The receivers are made tight by simply setting them on the pump-plate with a piece of wet or oiled leather between; and the receivers, which are open a-top, have a brass cover set on them in the same manner. In these covers there are various perforations and contrivances for various purposes. The one in the figure has a slip wire passing through a collar of oiled leather, having a hook or a screw in its lower end for hanging any thing on or producing a variety of motions.

Sometimes the receivers are set on another plate, which has a pipe screwed into its middle, furnished with a stopcock and a screw, which fits the middle pipe *k*. When the rarefaction has been made in it, the cock is shut, and then the whole may be unscrewed from the pump, and removed to any convenient place. This is called a *transporter plate*.

It only remains to explain the gage *llll*. In the ordinary state of the air its elasticity balances the pressure of the incumbent atmosphere. We find this from the force that is necessary to squeeze it into less bulk, in opposition to this elasticity. Therefore the elasticity of the air increases with the vicinity of its particles. It is therefore reasonable to expect, that when we allow it to occupy more room, and its particles are farther asunder, its elasticity will be diminished though not annihilated; that is, it will no longer balance the whole pressure of the atmosphere, though it may still balance part of it. If therefore an upright pipe have its lower end immersed in a vessel of mercury, and communicate by its upper end with a vessel containing rarefied, therefore less elastic, air, we should expect that the pressure of the air will prevail, and force the mercury into the tube, and cause it to rise to such an height that the weight of the mercury, joined to the elasticity of the rarefied air acting on its upper surface, shall be exactly equal to the whole pressure of the atmosphere. The height of the mercury is the exact measure of that part of the whole pressure which is not balanced by the elasticity of the rarefied air, and its deficiency from the height of the mercury in the Toricellian tube is the exact measure of this remaining elasticity.

Air-pump. It is evident therefore, that the pipe will be a scale of the elasticity of the remaining air, and will indicate in some sort the degree of rarefaction: for there must be some analogy between the density of the air and its elasticity; and we have no reason to imagine that they do not increase and diminish together, although we may be ignorant of the law, that is, of the change of elasticity corresponding to a known change of density. This is to be discovered by experiment; and the air-pump itself furnishes us with the best experiments for this purpose. After rarefying till the mercury in the gage has attained half the height of that in the Toricellian tube, shut the communication with the barrels and gage, and admit the water into the receiver. It will go in till all is again in equilibrio with the pressure of the atmosphere; that is, till the air in the receiver has collapsed into its natural bulk. This we can accurately measure, and compare with the whole capacity of the receiver; and thus obtain the precise degree of rarefaction corresponding to half the natural elasticity. We can do the same thing with the elasticity reduced to one third, one fourth, &c. and thus discover the whole law.

*con ni-
aces this
ge* This gage must be considered as one of the most ingenious and convenient parts of Hawkesbee's pump; and it is well disposed, being in a situation protected against accidents: but it necessarily increases greatly the size of the machine, and cannot be applied to the table-pump, represented in fig. 20, n^o 1. When it is wanted here, a small plate is added behind, or between the barrels and receiver; and on this is set a small tubulated (as it is termed) receiver, covering a common weather-glass tube.—This receiver being rarefied along with the other, the pressure on the mercury in the cistern arising from the elasticity of the remaining air is diminished so as to be no longer able to support the mercury at its full height; and it therefore descends till the height at which it stands puts it in equilibrio with the elasticity. In this form, therefore, the height of the mercury is directly a measure of the remaining elasticity; while in the other it measures the remaining unbalanced pressure of the atmosphere. But this gage is extremely cumbersome, and liable to accidents. We are seldom much interested in the rarefaction till it is great: a contracted form of this gage is therefore very useful, and was early used. A syphon ABCD (fig. 20, n^o 2.), each branch of which is about four inches long, close at A and open at D, is filled with boiling mercury till it occupies the branch AB and a very small part of CD, having its surface at O. This is fixed to a small stand, and fixed into the receiver, along with the things that are to be exhibited in the rarefied air. When the air has been rarefied till its remaining elasticity is not able to support the column BA, the mercury descends in AB, and rises in CD, and the remaining elasticity will always be measured by the elevation of the mercury in AB above that in the leg CD. Could the exhaustion be perfected, the surfaces in both legs would be on a level. Another gage might be put into the same foot, having a small bubble of air at A. This would move from the beginning of the rarefaction; but our ignorance of the analogy between the density and elasticity hinders us from using it as a measure of either.

It is enough for our present purpose to observe, that the barometer or syphon gage is a perfect indication

and measure of the performance of an air-pump, and that a pump is (*ceteris paribus*) so much the more perfect, as it is able to raise the mercury higher in the gage. It is in this way that we discover that none can produce a complete exhaustion, and that their operation is only a very great rarefaction: for none can raise the mercury to that height at which it stands in the Toricellian tube, well purged of air. Few pumps will bring it within $\frac{1}{10}$ of an inch. Hawkesbee's, fitted up according to his instructions, will seldom bring it within $\frac{1}{2}$. Pumps with cocks, when constructed according to the principles mentioned when speaking of the exhausting syringe, and new and in fine order, will in favourable circumstances bring it within $\frac{1}{4}$. None with valves fitted up with wet leather, or when water or volatile fluids are allowed access into any part, will bring it nearer than $\frac{1}{4}$. Nay, a pump of the best kind, and in the finest order, will have its rarefying power reduced to the lowest standard, as measured by this gage, if we put into the receiver the tenth part of a square inch of white sheep-skin, fresh from the shops, or of any substance equally damp. This is a discovery made by means of the improved air-pump, and leads to very extensive and important consequences in general physics; some of which will be treated of under this article: and the observation is made thus early, that our readers may better understand the improvements which have been made on this celebrated machine.

It would require a volume to describe all the changes which have been made on it. An instrument of such multifarious use, and in the hands of curious men, each diving into the secrets of nature in his favourite line, must have received many alterations and real improvements in many particular respects. But these are beside our present purpose; which is to consider it merely as a machine for rarefying elastic or expansive fluids. We must therefore confine ourselves to this view of it; and shall carefully state to our readers every improvement founded on principle, and on pneumatical laws.

All who used it perceived the limit set to the rarefaction by the resistance of the valves, and tried to perfect the construction of the cocks. The Abbé Nollet and Gravefande, two of the most eminent experimental philosophers in Europe, were the most successful.

Mr Gravefande justly preferred Hooke's plan of a double pump, and contrived an apparatus for turning the cocks by the motion of the pump's handle. This is far from either being simple or easy in working; and occasions great jerks and concussion in the whole machine. This, however, is not necessarily connected with the truly pneumatical improvement. His piston has no valve, and the rod is connected with it by a stirrup D (fig. 21), as in a common pump. The rod has a cylindric part *cp*, which passes through the stirrup, and has a stiff motion in it up and down of about half an inch; being stopped by the shoulder *c* above and the nut below. The round plate supported by this stirrup has a short square tube *nd*, which fits tight into the hole of a piece of cork F. The round plate E has a square shank *g*, which goes into the square tube *nd*. A piece of thin leather *f*, soaked in oil, is put between the cork and the plate E, and another between the cork and the plate which forms the sole of the stirrup. All these pieces are screwed together by the nail *e*, whose flat head covers the hole *n*. Suppose, therefore, the piston touching

116
Air-pump. touching the bottom of the barrel, and the winch turning to raise it again, the friction of the piston on the barrel keeps it in its place, and the rod is drawn up through the stirrup D. Thus the wheel has liberty to turn about an inch; and this is sufficient for turning the cock, so as to cut off the communication with the external air, and to open the communication with the receiver. This being done, and the motion of the winch continued, the piston is raised to the top of the barrel. When the winch is turned in the opposite direction, the piston remains fixed till the cock is turned, so as to shut the communication with the receiver, and open that with the external air.

117
A useful contrivance.

This is a pretty contrivance, and does not at first appear necessary; because the cocks might be made to turn at the beginning and end of the stroke without it. But this is just possible; and the smallest error of adjustment, or wearing of the apparatus, will cause them to be open at improper times. Besides, the cocks are not turned in an instant, and are improperly open during some very small time; but this contrivance completely obviates this difficulty.

118. The cock is precisely similar to that formerly described, having one perforation diametrically through it and another entering at right angles to this, and after reaching the centre, it passes along the axis of the cock, and comes out to the open air.

119
Its inconveniences

It is evident, that by this construction of the cock, the ingenious improvement of Dr Hooke, by which the pressure of the atmosphere on one piston is made to balance (in great part) the pressure on the other, is given up: for, whenever the communication with the air is opened, it rushes in, and immediately balances the pressure on the upper side of the piston in this barrel; so that the whole pressure in the other must be overcome by the person working the pump. Gravefande, aware of this, put a valve on the orifice of the cock; that is, tied a slip of wet bladder or oiled leather across it; and now the piston is pressed down, as long as the air in the barrel is rarer than the outward air, in the same manner as when the valve is in the piston itself.

121
Highly extolled, but

This is all that is necessary to be described in Mr Gravefande's air-pump. Its performance is highly extolled by him, as far exceeding his former pumps with valves. The same preference was given to it by his successor Muschenbroek. But, while they both prepared the pistons and valves and leathers of the pump, by steeping them in oil, and then in a mixture of water and spirits of wine, we are certain that no just estimate could be made of its performance. For with this preparation it could not bring the gage within $\frac{1}{4}$ of an inch of the barometer. We even see other limits to its rarefaction: from its construction, it is plain that a very considerable space is left between the piston and cock, not less than an inch, from which the air is never expelled; and if this be made extremely small, it is plain that the pump must be worked very slow, otherwise there will not be time for the air to diffuse itself from the receiver into the barrel, especially towards the end, when the expelling force, viz. the elasticity of the remaining air, is very small. There is also the same limit to the rarefaction, as in Hooke's or Hawkeesbee's pump, opposed by the valve E, which will not open till the air below the piston is considerably denser than the external air: and this pump soon lost any ad-

122
Limited in its operation.

vantages it possessed when fresh from the workman's Air-pump hands, by the cock's growing loose and admitting air. It is surprising that Gravefande omitted Hawkeesbee's security against this, by placing the barrels in a dish filled with oil; which would effectually have prevented this inconvenience.

We must not omit a seemingly paradoxical observation of Gravefande, that in a pump constructed with valves, and worked with a determined uniform velocity, the required degree of rarefaction is sooner produced by short barrels than by long ones. It would require too much time to give a general demonstration of this, but it will easily be seen by an example. Suppose the long barrel to have equal capacity with the receiver, then at the end of the first stroke the air in the receiver will have $\frac{1}{2}$ its natural density. Now, let the short barrels have half this capacity: at the end of the first stroke the density of the air in the receiver is $\frac{2}{3}$, and at the end of the second stroke it is $\frac{4}{9}$, which is less than $\frac{1}{2}$, and the two strokes of the short barrel are supposed to be made in the same time with one of the longest, &c.

Hawkeesbee's pump maintained its pre-eminence without rival in Britain, and generally too on the continent, except in France, where every thing took the *ton* of the Academy, which abhorred being indebted to foreigners for any thing in science, till about the year 1750, when it engaged the attention of Mr John Smeaton, a person of uncommon knowledge, and second to none but Dr Hooke in sagacity and mechanical resource. He was then a maker of philosophical instruments, and made many attempts to perfect the pumps with cocks, but found, that whatever perfection he could bring them to, he could not enable them to preserve it; and he never would sell one of this construction. He therefore attached himself solely to the valve pumps.

The first thing was to diminish the resistance to the entry of the air from the receiver into the barrels: this he rendered almost nothing, by enlarging the surface on which this feebly elastic air was to press. Instead of making these valves to open by its pressure on a circle of $\frac{1}{8}$ of an inch in diameter, he made the valve-hole one inch in diameter, enlarging the surface 400 times; and, to prevent this piece of thin leather from being burst by the great pressure on it, when the piston in its descent was approaching the bottom of the barrel, he supported it by a delicate but strong grating, dividing the valve-hole like the section of a honey-comb, as represented in fig. 22, n° 3; and the ribs of this grating are seen edgewise in fig. 22, n° 1, at *abc*.

The valve was a piece of thin membrane or oiled silk, gently strained over the mouth of the valve-hole, and tied on by a fine silk thread wound round it in the same manner that the narrow slips had been tied on formerly. This done, he cut with a pointed knife the leather round the edge, nearly four quadrantal arcs, leaving a small tongue between each, as in fig. 22, n° 3. The strained valve immediately shrinks inwards, as represented by the shaded parts; and the strain by which it is kept down is now greatly diminished, taking place only at the corners. The gratings being reduced nearly to an edge (but not quite, lest they should cut), there is very little pressure to produce adhesion by the clammy oil. Thus it appears, that a very small elasticity of the air in the receiver will be sufficient to raise the valve; and Mr Smeaton found, that

Air pump. that when it was not able to do this at first, when only about $\frac{1}{100}$ of the natural elasticity, it would do it after keeping the piston up eight or ten seconds, the air having been all the while undermining the valve, and gradually detaching it from the grating.

Unfortunately he could not follow this method with the piston valve. There was not room round the rod for such an expanded valve; and it would have obliged him to have a great space below the valve, from which he could not expel the air by the descent of the piston. His ingenuity hit on a way of increasing the expelling force through the common valve: he inclosed the rod of the piston in a collar of leather *l*, through which it moved freely without allowing any air to get past its sides. For greater security, the collar of leather was contained in a box terminating in a cup filled with oil. As this makes a material change in the principle of construction of the air-pump (and indeed of pneumatic engines in general), and as it has been adopted in all the subsequent attempts to improve them, it merits a particular consideration.

The piston itself consists of two pieces of brads fastened by screws from below. The uppermost, which is of one solid piece with the rod GH (fig. 22, n^o 1.), is of a diameter somewhat less than the barrel; so that when they are screwed together, a piece of leather soaked in a mixture of boiled oil and tallow, is put between them; and when the piston is thrust into the barrel from above, the leather comes up around the side of the piston, and fills the barrel, making the piston perfectly air-tight. The lower half of the piston projects upwards into the upper, which has a hollow *gbcg* to receive it. There is a small hole through the lower half at *a* to admit the air; and a hole *cd* in the upper half to let it through, and there is a slip of oiled silk strained across the hole *a* by way of valve, and there is room enough left at *bc* for this valve to rise a little when pressed from below. The rod GH passes through the piece of brads which forms the top of the barrel so as to move freely, but without any sensible shake: this top is formed into a hollow box, consisting of two pieces ECDF and CNOD, which screw together at CD. This box is filled with rings of oiled leather exactly fitted to its diameter, each having a hole in it for the rod to pass through. When the piece ECDF is screwed down, it compresses the leathers; squeezing them to the rod, so that no air can pass between them; and, to secure us against all ingress of air, the upper part is formed into a cup EF, which is kept filled with oil.

The top of the barrel is also pierced with a hole LK, which rises above the flat surface NO, and has a slip of oiled silk tied over it to act as a valve; opening when pressed from below, but shutting when pressed from above.

The communication between the barrel and receiver is made by means of the pipe ABPQ; and there goes from the hole K in the top of the barrel a pipe KRST, which either communicates with the open air or with the receiver, by means of the cock at its extremity T. The conduit pipe ABPQ has also a cock at Q, by which it is made to communicate either with the receiver or with the open air. These channels of communication are variously conducted and terminated, according to the views of the maker: the sketch in this figure is sufficient for explaining the principle, and is suited to the

general form of the pump, as it has been frequently Air-pump. made by Nairne and other artists in London.

Let us now suppose the piston at the top of the barrel, and that it applies to it all over, and that the air in the barrel is very much rarefied: in the common pump the piston valve is pressed hard down by the atmosphere, and continues shut till the piston gets far down, condenses the air below it beyond its natural state, and enables it to force up the valves. But here, as soon as the piston quits the top of the barrel, it leaves a void behind it; for no air gets in round the piston rod, and the valve at K is shut by the pressure of the atmosphere. There is nothing now to oppose the elasticity of the air below but the stiffness of the valve *bc*; and thus the expelling (or more accurately the liberating) force is prodigiously increased.

The superiority of this construction will be best seen by an example. Suppose the stiffness of the valve equal to the weight of $\frac{1}{10}$ of an inch of mercury, when the barometer stands at 30 inches, and that the pump gage stands at 29.9; then, in an ordinary pump, the valve in the piston will not rise till the piston has got within the 300th part of the bottom of the barrel, and it will leave the valve-hole filled with air of the ordinary density. But in this pump the valve will rise as soon as the piston quits the top of the barrel; and when it is quite down, the valve-hole *a* will contain only the 300th part of the air which it would have contained in a pump of the ordinary form. Suppose further, that the barrel is of equal capacity with the receiver, and that both pumps are so badly constructed, that the space left below the piston is the 300th part of the barrel. In the common pump the piston valve will rise no more, and the rarefaction can be carried no farther, however delicate the barrel valve may be; but in this pump the next stroke will raise the gage to 29.95, and the piston valve will again rise as soon as the piston gets half way down the barrel.

The limit to the rarefaction by this pump depends chiefly on the space contained in the hole LK; and in the space *bed* of the piston. When the piston is brought up to the top, and applied close to it, those spaces remain filled with air of the ordinary density, which will expand as the piston descends, and thus will retard the opening of the piston valve. The rarefaction will stop when the elasticity of this small quantity of air, expanded so as to fill the whole barrel (by the descent of the piston to the bottom), is just equal to the force requisite for opening the piston valve.

Another advantage attending this construction is, that in drawing up the piston, we are not resisted by the whole pressure of the air; because the air is rarefied above this piston as well as below it, and the piston is in precisely the same state of pressure as if connected with another piston in a double pump. The resistance to the ascent of the piston is the excess of the elasticity of the air above it over the elasticity of the air below: this, toward the end of the rarefaction, is very small, while the piston is near the bottom of the barrel, but gradually increases as the piston rises, and reduces the air above it into smaller dimensions, and becomes equal to the pressure of the atmosphere, when the air above the piston is of the common density. If we should raise the piston still farther, we must condense the air above it: but Mr Smeaton has here made an issue for the air by a small hole in the top of the barrel, covered with a delicate

Air pump. delicate valve. This allows the air to escape, and shuts again as soon as the piston begins to descend, leaving almost a perfect void behind it as before.

This pump has another advantage. It may be changed in a moment from a rarefying to a condensing engine, by simply turning the cocks at *Q* and *T*. While *T* communicates with the open air and *Q* with the receiver, it is a rarefying engine or air-pump: but when *T* communicates with the receiver, and *Q* with the open air, it is a condensing engine.

Fig. 23. represents Mr Smeaton's air-pump as it is usually made by Nairne. Upon a solid base or table are set up three pillars *F*, *H*, *H*: the pillar *F* supports the pump-plate *A*; and the pillars *H*, *H*, support the front or head, containing a brass cog-wheel, which is turned by the handle *B*, and works in the rack *C* fastened to the upper end of the piston rod. The whole is still farther steadyed by two pieces of brass *cb* and *ok*, which connect the pump-plate with the front, and have perforations communicating between the hole *a* in the middle of the plate and the barrel, as will be described immediately. *DE* is the barrel of the pump, firmly fixed to the table by screws thro' its upper flanch: *efdc* is a slender brass tube screwed to the bottom of the barrel, and to the under hole of the horizontal canal *cb*. In this canal there is a cock which opens a communication between the barrel and the receiver, when the key is in the position represented here: but when the key is at right angles with this position, this communication is cut off. If that side of the key which is here drawn next to the pump-plate be turned outward, the external air is admitted into the receiver; but if turned inwards, the air is admitted into the barrel.

gb is another slender brass pipe, leading from the discharging valve at *g* to the horizontal canal *bk*, to the under side of which it is screwed fast. In this horizontal canal there is a cock *n* which opens a passage from the barrel to the receiver when the key is in the position here drawn; but opens a passage from the barrel to the external air when the key is turned outwards, and from the receiver to the external air when the key is turned inwards. This communication with the external air is not immediate but through a sort of box *i*; the use of this box is to receive the oil which is discharged through the top valve *g*. In order to keep the pump tight, and in working order, it is proper sometimes to pour a table-spoonful of olive-oil into the hole *a* of the pump-plate, and then to work the pump. The oil goes along the conduit *bcdfe*, gets into the barrel and through the piston-valve, when the piston is pressed to the bottom of the barrel, and is then drawn up, and forced through the discharging valve *g* along the pipe *gb*, the horizontal passage *bn*, and finally into the box *i*. This box has a small hole in its side near the top, through which the air escapes.

From the upper side of the canal *cb* there rises a slender pipe which bends outward and then turns downwards, and is joined to a small box, which cannot be seen in this view. From the bottom of this box proceeds downwards the gage-pipe of glass, which enters the cistern of mercury *G* fixed below.

On the upper side of the other canal at *o* is seen a small stud, having a short pipe of glass projecting horizontally from it, close by and parallel to the front piece of the pump, and reaching to the other canal. This

pipe is close at the farther end, and has a small drop of Air-pump, mercury or oil in it at the end *o*. This serves as a gage in condensing, indicating the degree of condensation by the place of the drop: For this drop is forced along the pipe, condensing the air before it in the same degree that it is condensed in the barrel and receiver.

In constructing this pump, Mr Smeaton introduced a method of joining together the different pipes and other pieces, which has great advantages over the usual manner of screwing them together with leather between, and which is now much used in hydraulic and pneumatic engines. We shall explain this to our readers by a description of the manner in which the exhausting gage is joined to the horizontal duct *cb*.

The piece *bip*, in fig. 22, n^o 2. is the same with the little cylinder observable on the upper side of the horizontal canal *cd*, in fig. 23. The upper part *bi* is formed into an outside screw, to fit the hollow screw of the piece *deed*. The top of this last piece has a hole in its middle, giving an easy passage to the bent tube *cba*, so as to slip along it with freedom. To the end *c* of this bent tube is soldered a piece of brass *cfg*, perforated in continuation of the tube, and having its end ground flat on the top of the piece *bip*, and also covered with a slip of thin leather strained across it and pierced with a hole in the middle.

It is plain from this form, that if the surface *fg* be applied to the top of *bi*, and the cover *deed* be screwed down on it, it will draw or press them together, so that no air can escape by the joint, and this without turning the whole tube *cba* round, as is necessary in the usual way. This method is now adopted for joining together the conducting pipes of the machines for extinguishing fires, an operation which was extremely troublesome before this improvement.

The conduit pipe *Eefc* (fig. 23.) is fastened to the bottom of the barrel, and the discharging pipe *gb* to its top, in the same manner. But to return to the gage; the bent pipe *cba* enters the box *st* near one side, and obliquely, and the gage pipe *qr* is inserted through its bottom towards the opposite side. The use of this box is to catch any drops of mercury which may sometimes be dashed up through the gage pipe by an accidental oscillation. Thus, by going through the passages of the pump, would corrode them, and would act particularly on the joints, which are generally soldered with tin. When this happens to an air-pump, it must be cleaned with the most scrupulous attention, otherwise it will be quickly destroyed.

This account of Smeaton's pump is sufficient for enabling the reader to understand its operation and to see its superiority. It is reckoned a very fine pump of the ordinary construction which will rarefy 200 times, or raise the gage to 29.85, the barometer standing at 30. But Mr Smeaton found, that his pump, even after long using, raised it to 29.95, which we consider as equivalent to rarefying 600 times. When in fine order, he found no bounds to its rarefaction, frequently raising the gage as high as the barometer; and he thought its performance so perfect, that the barometer-gage was not sufficiently delicate for measuring the rarefaction. He therefore substituted the syphon gage already described, which he gives some reasons for preferring; but even this he found not sufficiently sensible.

He contrived another, which could be carried to

any degree of sensibility. It consisted of a glass body A (fig. 24.), of a pear shape, and was therefore called the pear-gage. This had a small projecting orifice at B, and at the other end a tube CD, whose capacity was the hundredth part of the capacity of the whole vessel. This was suspended at the slip-wire of the receiver, and there was set below it a small cup with mercury. When the pump was worked, the air in the pear-gage was rarefied along with the rest. When the rarefaction was brought to the degree intended, the gage was let down till B reached the bottom of the mercury. The external air being now let in, the mercury was raised into the pear, and stood at some height E in the tube CD. The length of this tube being divided into 100 parts, and those numbered from D, it is evident that $\frac{DE}{DB}$ will

express the degree of rarefaction which had been produced when the gage was immersed into the mercury: or if DC be $\frac{1}{100}$ of the whole capacity, and be divided into 100 parts by a scale annexed to it, each unit of the scale will be $\frac{1}{10000}$ of the whole.

This was a very ingenious contrivance, and has been the means of making some very curious and important discoveries which at present engage the attention of philosophers. By this gage Mr Smeaton found, that his pump frequently rarefied a thousand, ten thousand, nay an hundred thousand, times. But though he in every instance saw the great superiority of his pump above all others, he frequently found irregularities which he could not explain, and a want of correspondence between the pear and the barometer gages which puzzled him. The pear-gage frequently indicated a prodigious rarefaction, when the barometer-gage would not show more than 600.

These unaccountable phenomena excited the curiosity of philosophers, who by this time were making continual use of the air-pump in their meteorological researches, and much interested in every thing connected with the state or constitution of elastic fluids. Mr Nairne, a most ingenious and accurate maker of philosophical instruments, made many curious experiments in the examination and comparison of Mr Smeaton's pump with those of the usual construction, attending to every circumstance which could contribute to the inferiority of the common pumps or to their improvement, so as to bring them nearer to this rival machine. This rigorous comparison brought into view several circumstances in the constitution of the atmospheric air, and its relation to other bodies, which are of the most extensive and important influence in the operations of nature. We shall notice at present such only as have a relation to the operation of the air-pump: in extracting AIR from the receiver.

Mr Nairne found, that when a little water, or even a bit of paper damped with water, was exposed under the receiver of Mr Smeaton's air-pump, when in the most perfect condition, raising the mercury in the barometer-gage to 29.95, he could not make it rise above 29.8 if Fahrenheit's thermometer indicated the temperature 47°, nor above 29.7 if the thermometer stood at 55°; and that to bring the gage to this height and keep it there, the operation of the pump must be continued for a long time after the water had disappeared or the paper become perfectly dry. He found that a drop of spirits, or paper moistened with spirits, could not in

those circumstances allow the mercury in the gage to rise to near that height; and that similar effects followed from admitting any volatile body whatever into the receiver or any part of the apparatus.

This showed him at once how improper the directions were which had been given by Guericke, Boyle, Grævesande, and others, for fitting up the air-pump for experiment, by soaking the leather in water, covering the joints with water, or in short, admitting water or any other volatile body near it.

He therefore took his pumps to pieces, cleared them of all the moisture which he could drive from them by heat, and then leathered them anew with leather soaked in a mixture of olive oil and tallow, from which he had expelled all the water it usually contains, by boiling it till the first frothing was over. When the pumps were fitted up in this manner, he uniformly found that Mr Smeaton's pump rarefied the gage to 29.95, and the best common pump to 29.87, the first of which he computed to indicate a rarefaction to 600, and the other to 230. But in this state he again found that a piece of damp paper, leather, wood, &c. in the receiver, reduced the performance in the same manner as before.

But the most remarkable phenomenon was, that when he made use of the pear-gage with the pump cleared from all moisture, it indicated the same degree of rarefaction with the barometer-gage: but when he exposed a bit of paper moistened with spirits, and thus reduced the rarefaction of the pump to what he called 50, the barometer-gage standing at 29.4, the pear-gage indicated a rarefaction exceeding 100,000; in short, it was not measurable; and this phenomenon was almost constant. Whenever he exposed any substance susceptible of evaporation, he found the rarefaction indicated by the barometer-gage greatly reduced, while that indicated by the pear-gage was prodigiously increased; and both these effects were more remarkable as the subject was of easier evaporation, or the temperament of the air of the chamber was warmer.

This uniform result suggested the true cause. Water boils at the temperature 212, that is, it then converted into a vapour which is permanently elastic while of that temperature, and its elasticity balances the pressure of the atmosphere. If this pressure be diminished by rarefying the air above it, a lower temperature will now allow it to be converted into elastic vapour, and keep it in that state. Water will boil in the receiver of an air-pump at the temperament 96, or even under it. Philosophers did not think of examining the state of the vapour in temperatures lower than what produced ebullition. But it now appears, that in much lower heats than this the superficial water is converted into elastic vapour, which continues to exhale from it as long as the water lasts, and, supplying the place of air in the receiver, exerts the same elasticity, and hinders the mercury from rising in the gage in the same manner as so much air of equal elasticity would have done.

When Mr Nairne was exhibiting these experiments to the Honourable Henry Cavendish in 1776, this gentleman informed him that it appeared from a series of experiments of his father Lord Charles Cavendish, that when water is of the temperature 72°, it is converted into vapour, under any pressure less than three-fourths of an inch of mercury, and at 41° it becomes vapour when the pressure is less than one-fourth of an inch:

Even

Air-pump. Even mercury evaporates in this manner when all pressure is removed. A dewy appearance is frequently observed covering the inside of the tube of a barometer, where we usually suppose a vacuum. This dew, when viewed through a microscope, appears to be a set of detached globules of mercury, and upon inclining the tube so that the mercury may ascend along it, these globules will be all licked up, and the tube become clear. The dew which lined it was the vapour of the mercury condensed by the side of the tube; and it is never observed but when one side is exposed to a stream of cold air from a window, &c.

To return to the vapour in the air-pump receiver, it must be observed, that as long as the water continues to yield it, we may continue to work the pump; and it will be continually abstracted by the barrels, and discharged in the form of water, because it collapses as soon as exposed to the external pressure. All this while the gage will not indicate any more rarefaction, because the thing immediately indicated by the barometer-gage is *diminished elasticity*, which does not happen here. When all the water which the temperature of the room can keep elastic has evaporated under a certain pressure, suppose $\frac{1}{2}$ an inch of mercury, the gage standing at 29.5, the vapour which now fills the receiver expands, and by its diminished elasticity the gage rises, and now some more water which had been attached to bodies by chemical or corpuscular attraction is detached, and a new supply continues to support the gage at a greater height; and this goes on continually till *almost* all has been abstracted: but there will remain some which no art take can away; for as it passes through the barrels, and gets between the piston and the top, it successively collapses into water during the ascent of the piston, and again expands into vapour when we push the piston down again. Whenever this happens there is an end of the rarefaction.

145
Air and
vapour not
uniformly
mixed to-
gether.

While this operation is going on, the air comes out along with the vapour; but we cannot say in what proportion. If it were always uniformly mixed with the vapour, it would diminish rapidly; but this does not appear to be the case. There is a certain period of rarefaction in which a transient cloudiness is perceived in the receiver. This is watery vapour formed at that degree of rarefaction, mingled with, but not dissolved in or united with, the air, otherwise it would be transparent. A similar cloud will appear if damp air be admitted suddenly into an exhausted receiver. The vapour, which formed an uniform transparent mass with the air, is either suddenly expanded and thus detached from the other ingredient, or is suddenly let go by the air, which expands more than it does. We cannot affirm with probability which of these is the case: different compositions of air, that is, air loaded with vapours from different substances, exhibit remarkable differences in this respect. But we see from this and other phenomena, which shall be mentioned in their proper places, that the air and vapour are not always intimately united; and therefore will not always be drawn out together by the air-pump. But let them be ever so confusedly blended, we see that the air must come out along with the vapour, and its quantity remaining in the receiver must be prodigiously diminished by this association, probably much more than could be, had the receiver only contained pure air.

Let us now consider what must happen in the pear-gage. As the air and vapour are continually drawn off from the receiver, the air in the pear expands and goes off with it. We shall suppose that the generated vapour hinders the gage from rising beyond 29.5. During the continued working of the pump, the air in the pear, whose elasticity is 0.5, slowly mixes with the vapour at the mouth of the pear, and the mixture even advances into its inside, so that if the pumping be long enough continued, what is in the pear is nearly of the same composition with what is in the receiver, consisting perhaps of 20 parts of vapour and one part of air, all of the elasticity of 0.5. When the pear is plunged into the mercury, and the external air allowed to get into the receiver, the mercury rises in the pear-gage, and leaves not $\frac{1}{60}$, but $\frac{1}{60 \times 20}$ or $\frac{1}{1200}$ of it filled with common air, the vapour having collapsed into an invisible atom of water. Thus the pear-gage will indicate a rarefaction of 1200, while the barometer-gage only showed 60, that is, showed the elasticity of the included substance diminished 60 times. The conclusion to be drawn from these two measures (the one of the rarefaction of air, and the other of the diminution of elasticity) is, that the matter with which the receiver was filled, immediately before the readmission of the air, consisted of one part of incondensable air, and $\frac{1200}{60}$, or 20 parts of watery vapour.

The only obscure part of this account is what relates to the composition of the matter which filled the pear-gage before the admission of the mercury. It is not easy to see how the vapour of the receiver comes in by a narrow mouth while the air is coming out by the same passage. Accordingly it requires a *very long time* to produce this extreme rarefaction in the pear-gage; and there are great irregularities in any two succeeding experiments, as may be seen by looking at Mr Nairne's account of them in Philosophical Transactions, Vol. LXVII. Some vapours appear to have mixed much more readily with the air than others; and there are some unaccountable cases where vitriolic acid and sulphureous bodies were included, in which the diminution of density indicated by the pear-gage was uniformly less than the diminution of elasticity indicated by the barometer-gage. It is enough for us at present to have established, by unquestionable facts, this production of elastic vapour, and the necessity of attending to it, both in the construction of the air-pump and in drawing results from experiments exhibited in it.

Mr Smeaton's pump, when in good order, and perfectly free from all moisture, will in dry weather rarefy air about 600 times, raising the barometer-gage to within $\frac{1}{20}$ of an inch of a fine barometer. This was a performance so much superior to that of all others, and by means of Mr Nairne's experiments opened so new a field of observation, that the air-pump once more became a capital instrument among the experimental philosophers. The causes of its superiority were also so distinct, that artists were immediately excited to a farther improvement of the machine; so that this becomes a new epoch in its history.

This is one imperfection which Mr Smeaton has not attempted to remove. The discharging valve is still open-
ed

ed against the pressure of the atmosphere. An author of the Swedish academy adds a subsidiary pump to this valve, which exhausts the air from above it, and thus puts it in the situation of the piston valve. We do not find that this improvement has been adopted so as to become general. Indeed the quantity of air which remains in the passage to this valve is so exceedingly little, that it does not seem to merit attention. Supposing the valve-hole $\frac{1}{8}$ of an inch wide and as deep (and it need not be more), it will not occupy more than $\frac{1}{8000}$ part of a barrel twelve inches long and two inches wide.

Mr Smeaton, by his ingenious construction, has greatly diminished, but has not annihilated, the obstructions to the passage of the air from the receiver into the barrel. His success encouraged farther attempts. One of the first and most ingenious was that of Professor Ruffel of the university of Edinburgh, who about the year 1770 constructed a pump in which both cocks and valves were avoided.

The piston is solid, as represented in fig. 25. and its rod passes through a collar of leather on the top of the barrel. This collar is divided into three portions by two brass rings *a, b*, which leave a very small space round the piston rod. The upper ring *a* communicates by means of a lateral perforation with the bent tube *lmn*, which enters the barrel at its middle *n*. The lower ring *b* communicates with the bent tube *cd*, which communicates with the horizontal passage *de*, going to the middle *e* of the pump plate. By the way, however, it communicates also with a barometer gage *po*, standing in a cistern of mercury *o*, and covered with a glass tube close at the top. Beyond *e*, on the opposite circumference of the receiver plate, there is a cock or plug *f* communicating with the atmosphere.

The piston rod is closely embraced by the three collars of leather; but, as already said, has a free space round it in the two brass rings. To produce this pressure of the leathers to the rod, the brass rings which separate them are turned thinner on the inner side, so that their cross section along a diameter would be a taper wedge. In the side of the piston rod are two cavities *qr, ts*, about one-tenth of an inch wide and deep, and of a length equal to the thickness of the two rings *a, b*, and the intermediate collar of leathers. These cavities are so placed on the piston-rod, that when the piston is applied to the bottom of the barrel, the cavity *ts* in the upper end of the rod has its upper end opposite to the ring *a*, and its lower end opposite to the ring *b*, or to the mouth of the pipe *cd*. Therefore, if there be a void in the barrel, the air from the receiver will come from the pipe *cd* into the cavity in the piston rod, and by it will get past the collar of leather between the rings, and thus will get into the small interstice between the rod and the upper ring, and then into the pipe *lmn*, and into the empty barrel. When the piston is drawn up, the solid rod immediately shuts up this passage, and the piston drives the air through the discharging valve *k*. When it has reached the top of the barrel, and is closely applied to it, the cavity *qr* is in the situation in which *ts* formerly was, and the communication is again opened between the receiver and the empty barrel, and the air is again diffused between them. Pushing down the piston expels the air by the lower discharging pipe and valve *hi*; and thus the operation may be continued.

VOL. XV. Part I.

This must be acknowledged to be a most simple and ingenious construction, and can neither be called a cock nor a valve. It seems to oppose no obstruction whatever: and it has the superior advantage of rarefying both during the ascent and the descent of the piston, doubling the expedition of the performance, and the operator is not opposed by the pressure of the atmosphere except towards the end of each stroke. The expedition, however, is not so great as one should expect; for nothing is going on while the piston is in motion, and the operator must stop a while at the end of each stroke, that the air may have time to come through this long, narrow, and crooked passage, to fill the barrel. But the chief difficulty which occurred in the execution arose from the clammy oil with which it was necessary to impregnate the collar of leathers. These were always in a state of strong compression, that they might closely grasp the piston rod, and prevent all passage of air during the motion of the piston. Whenever therefore the cavities in the piston rod come into the situations necessary for connecting the receiver and barrel, this oil is squeezed into them, and chokes them up. Hence it always happened that it was some time after the stroke before the air could force its way round the piston rod, carrying with it the clammy oil which choked up the tube *lmn*; and when the rarefaction had proceeded a certain length, the diminished elasticity of the air was not able to make its way through these obstructions. The death of the ingenious author put a stop to the improvements by which he hoped to remedy this defect, and we have not heard that any other person has since attempted it. We have inserted it here, because its principle of construction is not only very ingenious, but entirely different from all others, and may furnish very useful hints to those who are much engaged in the construction of pneumatic engines.

In the 73d volume of the Philosophical Transactions, By Haas and Hurter, 152
Mr Tiberius Cavallo has given the description of an air-pump contrived and executed by Messrs Haas and Hurter, instrument-makers in London, where these artists have revived Guericke's method of opening the barrel-valve during the last strokes of the pump by a force acting from without. We shall insert so much of this description as relates to this distinguishing circumstance of its construction.

Fig. 26. represents a section of the bottom of the barrel, where AA is the barrel and BB the bottom, which has in its middle a hollow cylinder CCFF, projecting about half an inch into the barrel at CC, and extending a good way downwards to FF. The space between this projection and the sides of the barrel is filled up by a brass ring DD, over the top of which is strained a piece of oiled silk EE, which performs the office of a valve, covering the hole CC. But this hole is filled up by a piece of brass, or rather an assemblage of pieces screwed together GGHII. It consists of three projecting fillets or shoulders GG, HH, II, which form two hollows between them, and which are filled with rings of oiled leather OO, PP, firmly screwed together. The extreme fillets GG, II, are of equal diameter with the inside of the cylinder, so as to fill it exactly, and the whole stuffed with oiled leather, slide up and down without allowing any air to pass. The middle fillet HH is not so broad, but thicker. In the upper fillet GG there is formed a shallow dish about $\frac{1}{2}$ of an inch deep

Air-pump.

deep and $\frac{1}{2}$ wide. This dish is covered with a thin plate, pierced with a grating like Mr Smeaton's valve-plate. There is a perforation VX along the axis of this piece, which has a passage out at one side H, through the middle fillet. Opposite to this passage, and in the side of the cylinder CCFF, is a hole M, communicating with the conduit pipe MN, which leads to the receiver. Into the lower end of the perforation is screwed the pin KL, whose tail L passes through the cap FF. The tail L is connected with a lever RQ, moveable round the joint Q. This lever is pushed upwards by a spring, and thus the whole piece which we have been describing is kept in contact with the slip of oiled silk or valve EE. This is the usual situation of things.

253

Now suppose a void formed in the barrel by drawing up the piston; the elasticity of the air in the receiver, in the pipe NM, and in the passage XV, will press on the great surface of the valve exposed through the grating, will raise it, and the pump will perform precisely as Mr Smeaton's does. But suppose the rarefaction to have been so long continued, that the air is no longer able to raise the valve; this will be seen by the mercury rising no more in the pump-gage. When this is perceived, the operator must press with his foot on the end R of the lever RQ. This draws down the pin KL, and with it the whole hollow plug with its grated top. And thus, instead of raising the valve from its plate, the plate is here drawn down from the valve. The air now gets in without any obstruction whatever, and the rarefaction proceeds as long as the piston rises. When it is at the top of the barrel, the operator takes his foot from the lever, and the spring presses up the plug again and shuts the valve. The piston rod passes through a collar of leather, as in Mr Smeaton's pump, and the air is finally discharged through an outward valve in the top of the barrel. These parts have nothing peculiar in them.

This is an ingenious contrivance, similar to what was adapted by Guericke himself; and we have no doubt of these pumps performing extremely well if carefully made: and it seems not difficult to keep the plug perfectly air-tight by supplying plenty of oil to the leathers. We cannot say, however, with precision what may be expected from it, as no account has been given of its effects besides what Mr Cavallo published in Philosophical Transactions 1783, where he only says, that when it had been long used, it had, in the course of some experiments, rarefied 600 times.

154
By Prince,

Aiming still at the removing the obstructions to the entry of the air from the receiver into the barrels, Mr Prince, an American, has constructed a pump in which there is no valve or cock whatever between them. In this pump the piston rod passes through a collar of leathers, and the air is finally discharged through a valve, as in the two last. But we are chiefly to attend, in this place, to the communication between the barrel and the receiver. The barrel widens below into a sort of cistern ABCD (fig. 27.), communicating with the receiver by the pipe EF. As soon, therefore, as the piston gets into this wider part, where there is a vacancy all round it, the air of the receiver expands freely through the passage FEE into the barrel, in which the descent of the piston had made a void. When the piston is again drawn up, as soon as it gets into the cylindric part of the barrel, which

Plate
CCCII.

it exactly fills, it carries up the air before it, and expels it by the top valve; and, that this may be done more completely, this valve opens into a second barrel or air-pump whose piston is rising at the same time, and therefore the valve of communication (which is the discharging valve of the primary pump) opens with the same facility as Mr Smeaton's piston valve. While the piston is rising, the air in the receiver expands into the barrel; and when the piston descends, the air in the barrel again collapses till the piston gets again into the cistern, when the air passes out, and fills the evacuated barrel, to be expelled by the piston as before.

No distinct account has as yet been given of the performance of this pump. We only learn that great inconveniences were experienced from the oscillations of the mercury in the gage. As soon as the piston comes into the cistern, the air from the receiver immediately rushes into the barrel, and the mercury shoots up in the gage, and gets into a state of oscillation. The subsequent rise of the piston will frequently keep time with the second oscillation, and increase it. The descent of the piston produces a downward oscillation, by allowing the air below it to collapse; and, by improperly timing the strokes, this oscillation becomes so great as to make the mercury enter the pump. To prevent this, and a greater irregularity of working as a condenser, valves were put in the piston: but as these require force to open them, the addition seemed rather to increase the evil, by rendering the oscillations more simultaneous with the ordinary rate of working. If this could be got over, the construction seems very promising.

It appears, however, of very difficult execution. It has many long, slender, and crooked passages, which must be drilled through broad plates of brass, some of them appearing scarcely practicable. It is rare to find plates and other pieces of brass without air-holes, which it would be very difficult to find out and to close; and it must be very difficult to clear it of obstructions: so that it appears rather a suggestion of theory than a thing warranted by its actual performance.

Mr Lavoisier, or some of the naturalists who were occupied in concert with him in the investigation of the different species of gas which are disengaged from bodies in the course of chemical operations, has contrived an air-pump which has great appearance of simplicity, and, being very different from all others, deserves to be taken notice of.

It consists of two barrels *l, m*, fig. 28. with solid pistons *kk*. The pump-plate *ab* is pierced at its centre *c* with a hole which branches towards each of the barrels, as represented by *cd, ce*. Between the plate and the barrels slides another plate *bi*, pierced in the middle with a branched hole *fdg*, and near the ends with two holes *hh, ii*, which go from its under side to the ends. The holes in these two plates are so adjusted, that when the plate *bi* is drawn so far towards *b* that the hole *i* comes within the barrel *m*, the branch *df* of the hole in the middle plate coincides with the branch *cd* of the upper plate, and the holes *e, g* are shut. Thus a communication is established between the barrel *l* and the receiver on the pump-plate, and between the barrel *m* and the external air. In this situation the barrel *l* will exhaust, and *m* will discharge. When the piston of *l* is at its mouth, and that of *m* touches its bottom, the sliding plate is shifted over to the other side, so that

m com-

np. communicates with the receiver through the passage *gd, ec*, and *l* communicates with the air by the passages *bb*.

It is evident that this sliding plate performs the office of four cocks in a very beautiful and simple manner, and that if the pistons apply close to the ends of the barrels, so as to expel the whole air, the pump will be perfect. It works, indeed, against the whole pressure of the external air. But this may be avoided by putting valves on the holes *h, i*; and these can do no harm, because the air remaining in them never gets back into the barrel till the piston be at the farther end, and the exhaustion of that stroke completed. But the best workmen of London think that it will be incomparably more difficult to execute this cock (for it is a cock of an unusual form), in such a manner that it shall be air-tight and yet move with tolerable ease, and that it is much more liable to wearing loose than common cocks. No accurate accounts have been received of its performance. It must be acknowledged to be ingenious, and it may suggest to an intelligent artist a method of combining common conical cocks upon one axis so as to answer the same purposes much more effectually; for which reason we have inserted it here.

The last improvement which we shall mention is that published by Mr Cuthbertson philosophical instrument-maker in Amsterdam. His pump has given such evidences of its perfection, that we can hardly expect or wish for any thing more complete. But we must be allowed to observe, beforehand, that the same construction was invented, and, in part, executed before the end of 1779, by Dr Daniel Rutherford, now professor of botany in the university of Edinburgh, who was at that time engaged in experiments on the production of air during the combustion of bodies in contact with nitre, and who was vastly desirous of procuring a more complete abstraction of pure aerial matter than could be effected by Mr Smeaton's pump. The compiler of this article had then an opportunity of perusing the Doctor's dissertation on this subject, which was read in the Philosophical Society of Edinburgh. In this dissertation the Doctor appears fully apprised of the existence of pure vital air in the nitrous acid as its chief ingredient, and as the cause of its most remarkable phenomena, and to want but a step to the discoveries which have ennobled the name of Mr Lavoisier. He was particularly anxious to obtain *apart* this distinguishing ingredient in its composition, and, for this purpose, to abstract completely from the vessel in which he subjected it to examination, every particle of elastic matter. The writer of this article proposed to him to cover the bottom of Mr Smeaton's piston with some clammy matter, which should take hold of the bottom valve, and *start* it when the piston was drawn up. A few days after, the Doctor showed him a drawing of a pump, having a conical metal valve in the bottom, furnished with a long slender wire, sliding in the inside of the piston-rod with a gentle friction, sufficient for lifting the valve, and se-

cured against all chance of failure by a spring a-top, *Air-pump.* which took hold of a notch in the inside of the piston-rod about a quarter of an inch from the lower end, so as certainly to lift the valve during the last quarter of an inch of the piston's motion. Being an excellent mechanic, he had executed a valve on this principle, and was fully satisfied with its performance. But having already confirmed his doctrines respecting the nitrous acid by incontrovertible experiments, his wishes to improve the air-pump lost their incitement, and he thought no more of it; and not long after this, the ardour of the philosophers of the Teylerian Society at Haerlem and Amsterdam excited the efforts of Mr Cuthbertson, their instrument-maker, to the same purpose, and produced the most perfect air-pump that has yet appeared. We shall give a description of it, and an account of its performance, in the inventor's own words.

CUTHBERTSON'S *Air-Pump*.

Plate CCCCVIII. is a perspective view of this pump, with its two principal gages screwed into their places. These need not be used together, except in cases where the utmost exactness is required. In common experiments one of them is removed, and a stop-screw put in its place. When the pear-gage is used, a small round plate, on which the receiver may stand, must be first screwed into the hole at A; but this hole is stopped on other occasions with a screw. When all the three gages are used, and the receiver is exhausted, the stop-screw B, at the bottom of the pump, must be unscrewed, to admit the air into the receiver; but when they are not all used, either of the other stop-screws will answer this purpose.

Fig. 2. represents a cross-bar for preventing the barrels from being shaken by working the pump or by any accident. Its place in fig. 1. is represented by the dotted lines. It is confined in its place, and kept close down on the barrels by two slips of wood NN, which must be drawn out, as well as the screws OO, when the pump is to be taken asunder.

Plate CCCCIX. is a section of all the working parts of the pump, except the wheel and rack, in which there is nothing uncommon.

Fig. 1. is a section of one of the barrels, with all its internal parts; and fig. 2, 3, 4, and 5, are different parts of the piston, proportioned to the size of the barrel (A) and to one another.

In fig. 1. CD represents the barrel, F the collar of leathers, G a hollow cylindrical vessel to contain oil, R is also an oil-vessel to receive the oil which is drawn, along with the air, through the hole *aa*, when the piston is drawn upwards; and, when this is full, the oil is carried over with the air, along the tube T, into the oil-vessel G. *cc* is a wire which is driven upwards from the hole *aa* by the passage of the air; and as soon as this has escaped, it falls down again by its own weight, shuts up the hole, and prevents all return of the air into the barrel. At *dd* are fixed two pieces of brass, to keep the wire *cc* in a vertical direction, that it may accurately shut the hole. H is a cylindrical

O 2

(A) The piston and barrel are 1,65 inches in diameter, in proportion to which the scale is drawn. Figures 2, 3, 4, 5, are, however, of double size.

Air-pump. cal wire or rod which carries the piston I, and is made hollow to receive a long wire *gg*, which opens and shuts the hole L; and on the other end of the wire O is screwed a nut, which, by stopping in the narrowest part of the hole, prevents the wire from being driven up too far. This wire and screw are more clearly seen in fig. 2. and 6; they slide in a collar of leather *rr*, fig. 2. and 5. in the middle piece of the piston. Fig. 4. and 5. are the two mean parts which compose the piston, and, when the pieces 3. and 6. are added to it, the whole is represented by fig. 2. Fig. 5. is a piece of brass of a conical form, with a shoulder at the bottom. A long hollow screw is cut in it, about $\frac{2}{3}$ of its length, and the remainder of the hole, in which there is no screw, is of about the same diameter with the screwed part, except a thin plate at the end, which is of a width exactly equal to the thickness of *gg*. That part of the inside of the conical brass in which no thread is cut, is filled with oiled leathers with holes through which *gg* can slide stiffly. There is also a male screw with a hole in it, fitted to *gg*, serving to compress the leathers *rr*. In fig. 4. *aaaa* is the outside of the piston, the inside of which is turned so as exactly to fit the outside of fig. 5. *bb* are round leathers about 60 in number, *cc* is a circular piece of brass of the size of the leathers, and *dd* is a screw serving to compress them. The screw at the end of fig. 3. is made to fit the screw in fig. 5. Now if fig. 6. be pushed into fig. 5, this into fig. 4, and fig. 3. be screwed into the end of fig. 5, these will compose the whole of the piston, as represented in fig. 2. H in fig. 1. represents the same part as H in fig. 2, and is that to which the rack is fixed. If, therefore, this be drawn upwards, it will cause fig. 5. to shut close into fig. 4, and drive out the air above it; and when it is pushed downward, it will open as far as the shoulder *aa* will permit, and suffer air to pass through. AA fig. 7. is the receiver plate, BB is a long square piece of brass, screwed into the under side of the plate, through which a hole is drilled corresponding to that in the centre of the receiver-plates and with three female screws *b, b, c*.

The rarefaction of the air in the receiver is effected as follows. Suppose the piston at the bottom of the barrel. The inside of the barrel, from the top of the piston to *a*, contains common air. When the rod is drawn up, the upper part of the piston sticks fast in the barrel till the conical part connected with the rod shuts the conical hole, and its shoulder applies close to its bottom. The piston is now shut, and therefore the *whole* is drawn up by the rack-work, driving the air before it through the hole *aa*, into the oil-vessel at R, and out into the room by the tube T. The piston will then be at the top of the barrel at *a*, and the wire *gg* will stand nearly as represented in the figure just raised from the hole L, and prevented from rising higher by the nut O. During this motion the air will expand in the receiver, and come along the bent tube *m* into the barrel. Thus the barrel will be filled with air, which, as the piston rises, will be rarefied in proportion as the capacity of the receiver, pipes, and barrel is to the barrel alone. When the piston is moved down again by the rack-work, it will force the conical part fig. 5. out of the hollow part fig. 4. as far as the shoulders *aa*; fig. 2. will rest on *aa* fig. 4, which will then be so far open as to permit the air to pass freely through it,

while at the same time the end of *gg* is forced against Air-pum the top of the hole, and shuts it in order to prevent any air from returning into the receiver. Thus the piston, moving downwards, suffers the air to pass out between the sides of fig. 4. and 5.; and, when it is at the bottom of the barrel, will have the column of air above it; and, consequently, when drawn upwards it will shut, and drive out this air, and, by opening the hole L at the same time, will give a free passage to more air from the receiver. This process being continued, the air of the receiver will be rarefied *as far as its expansive power will permit*. For in this machine there are no valves to be forced open by the elasticity of the air in the receiver, which at last it is unable to effect. There is therefore nothing to prevent the air from expanding to its utmost degree.

It may be suspected here, that as the air must escape thro' the discharging passage *ac*, Plate CCCCIX. fig. 1. against the pressure of a column of oil and the weight of the wire, there will remain in this passage a quantity of air of considerable density, which will expand again into the barrel during the descent of the piston, and thus put a stop to the progress of rarefaction. This is the case in Mr Smeaton's pump, and all which have valves in the piston. But it is the peculiar excellency of this pump, that whatever be the density of the air remaining in *ac*, the rarefaction will still go on. It is worth while to be perfectly convinced of this. Let us suppose that the air contained in *ac* is $\frac{1}{1000}$ part of the common air which would fill the barrel, and that the capacity of the barrel is equal to that of the receiver and passages, and that the air in the receiver and barrel is of the same density, the piston being at the bottom of the barrel: The barrel will therefore contain $\frac{1}{1000}$ parts of its natural quantity, and the receiver $\frac{1}{1000}$. Now let the piston be drawn up. No air will be discharged at *ac*, because it will contain the whole air which was in the barrel, and which has now collapsed into its ordinary bulk. But this does not in the least hinder the air of the receiver from expanding into the barrel, and diffusing itself equally between both. Each will now contain $\frac{1}{2000}$ of their ordinary quantity when the piston is at the top, and *ac* will contain $\frac{1}{1000}$ as before, or $\frac{1}{1000}$. Now push down the piston. The hole L is instantly shut, and the air in *ac* expands into the barrel, and the barrel now contains $\frac{1}{1000}$. When the piston has reached the bottom, let it be again drawn up. There will be $\frac{1}{2000}$ discharged through *c*, and the air in the receiver will again be equally distributed between it and the barrel. Therefore the receiver will now contain $\frac{2}{1000}$. When the piston reaches the bottom, there will be $\frac{12}{1000}$ in the barrel. When again drawn up to the top, there will be $\frac{2}{1000}$ discharged, and the receiver will contain $\frac{1}{1000}$; and when the piston reaches the bottom, there will be $\frac{11}{1000}$. At the next stroke the receiver will contain only $\frac{0.5}{1000}$, &c. &c.

Thus it appears, that notwithstanding the $\frac{1}{1000}$ which always

Air-pump. always expands back again out of the hole *ac* into the barrel, the rarity of the air in the receiver will be doubled at every stroke. There is therefore no need of a subsidiary air-pump at *c*, as in the American air-pump, and in the Swedish attempt to improve Smeaton's.

In using this air-pump no particular directions are necessary, nor is any peculiar care necessary for keeping it in order, except that the oil-vessel *A* be always kept about half full of oil. When the pump has stood long without being used, it will be proper to draw a table-spoonful of olive-oil through it, by pouring it into the hole in the middle of the receiver-plate when the piston is at the bottom of the barrel. Then by working the piston, the oil will be drawn through all the parts of the pump, and the surplus will be driven through the tube *T* into the oil-vessel *G*. Near the top of the piston-rod at *H* there is a hole which lets some oil into the inside of the rod, which gets at the collar of leathers *rr*, and keeps the wire *gg* air-tight.

When the pump is used for condensation at the same time that it rarefies, or separately, the piece containing the bent tube *T* must be removed, and fig. 8. put into its place, and fixed by its screws. Fig. 8. as drawn in the plate, is intended for a double barreled pump. But for a single barrel only one piece is used, represented by *baa*, the double piece being cut off at the dotted line *aa*. In this piece is a female screw to receive the end of a long brass tube, to which a bladder (if sufficient for the experiment of condensation), or a glass, properly secured for this purpose, must be screwed. Then the air which is abstracted from the receiver on the pump-plate will be forced into the bladder or glass. But if the pump be double, the apparatus fig. 8. is used, and the long brass tube screwed on at *c*.

Fig. 9. and 10. represent the two gages, which will be sufficiently explained afterwards. Fig. 9. is screwed into *cb*, or into the screw at the other end of *c* fig. 7. and fig. 10. into the screw *ab* fig. 7.

If it be used as a single pump, either to rarefy or condense, the screw *K*, which fastens the rack to the piston-rod *H*, must be taken out. Then turning the winch till *H* is depressed as low as possible, the machine will be fitted to exhaust as a single pump; and if it be required to condense, the direction in n^o 8. must be observed with regard to the tube *T*, and fig. 8.

"I took (says Mr Cuthbertson) two barometer-tubes of an equal bore with that fixed to the pump. These were filled with mercury four times boiled. They were then compared, and stood exactly at the same height. The mercury in one of them was boiled in it four times more, without making any change in their height; they were therefore judged very perfect. One of these was immersed in the cistern of the pump-gage, and fastened in a position parallel to it, and a sliding scale of one inch was attached to it. This scale, when the gage is used, must have its upper edge set equal with the surface of the mercury in the boiled tube after exhaustion, and the difference between the height of the mercury in this and in the other barometer tube may be observed to the $\frac{1}{100}$ of an inch; and being close together, no error arises from their not being exactly vertical, if they are only parallel. This gage will be better understood by inspecting fig. 10.

"I used a second gage, which I shall call a double **Air-pump.** syphon. See Plate CCCCIX. fig. 9. This was also prepared with the utmost care. I had a scale for measuring the difference between the height of the columns in the two legs. It was an inch long, and divided as the former, and kept in a truly vertical position by suspending it from a point with a weight hung to it, as represented in the figure. Upon comparing these two gages, I always found them to indicate the same degree of rarefaction. I also used a pear-gage, though the most imperfect of all, in order to repeat the curious experiments of Mr Nairne and others."

When experiments require the utmost rarefying power of the pump, the receiver must not be placed on leather, either oiled or soaked in water, as is usually done. The pump-plate and the edge of the receiver must be ground very flat and true, and this with very fine emery, that no roughness may remain. The plate of the pump must then be wiped very clean and very dry, and the receiver rubbed with a warm cloth till it become electrical. The receiver being now set on the plate, hog's lard, either alone or mixed with a little oil, which has been cleared of water by boiling, must be smeared round its outside edge. In this condition the pump will rarefy its utmost, and what still remains in the receiver will be permanent air. Or a little of this composition may be thinly smeared on the pump-plate; this will prevent all risk of scratching it with the edge of the receiver. Leather of very uniform thickness, long dried before a fire, and well soaked in this composition, which must be cleared of all water by the first boiling, will answer very well, and is expeditious, when receivers are to be frequently shifted. Other leathers should be at hand soaked in a composition containing a little rosin. This gives it a clamminess which renders it impermeable to air, and is very proper at all joints of the pump, and all apparatus for pneumatic experiments. As it is impossible to render the pear-gage as dry as other parts of the apparatus, there will be generally some variation between this and the other gages.

When it is only intended to show the utmost power of the pump, without intending to ascertain the quality of the residuum, the receiver may be set on wet leather. If, in this condition, the air be rarefied as far as possible, the syphon and barometer gage will indicate a less degree of rarefaction than in the former experiments. But when the air is let in again, the pear-gage will point out a rarefaction some thousands of times greater than it did before. If the true quality of permanent air after exhaustion be required, the pear-gage will be nearest the truth: for when the air is rarefied to a certain degree, the moistened leather emits an expansible fluid, which, filling the receiver, forces out the permanent air; and the two first gages indicate a degree of exhaustion which relates to the whole elastic matter remaining in the receiver, viz. to the expansible fluid together with the permanent air; whereas the pear-gage points out the degree of exhaustion, with relation to the permanent air alone, which remains in the receiver; for by the pressure of the air admitted into the receiver, the elastic vapour is reduced to its former bulk, which is imperceptible.

Many bodies emit this elastic fluid when the pressure of the air is much diminished; a piece of leather, in its ordinary

Air-pump. ordinary damp state, about an inch square, or a bit of green or dry wood, will supply this for a great while.

When such fluids have been generated in any experiments, the pump must be carefully cleared of them, for they remain not only in the receiver, but in the barrels and passages, and will again expand when the exhaustion has been carried far.

The best method of clearing the pump is to take a very large receiver, and, using every precaution to exhaust it as far as possible. Then the expansible matter lurking in the barrels and passes will be diffused through the receiver also, or will be carried off along with its air. It will be as much rarer than it was before, as the aggregate capacity of the receiver barrels and passes is larger than that of the two last.

The performance of the pump may be judged of from the four following experiments.

The two gages being screwed into their places, and the hole in the receiver-plate shut up, the pump was made to exhaust as far as it could. The mercury in the legs of the syphon was only $\frac{1}{4}$ of an inch out of the level, and that in the boiled barometer-tube $\frac{1}{8}$ of an inch higher than in the one screwed to the pump. A standard barometer then stood at 30 inches, and therefore the pump rarefied the permanent air 1200 times. This is twice as much as Mr Nairne found Mr Smeaton's do in its best state. Mr Cavallo seems disposed to give a favourable (while we must suppose it a just) account of Haas and Hurter's pump, and it appears never to have exceeded 600 times. Mr Cuthbertson has often found the mercury within $\frac{1}{16}$ of an inch of the level in the syphon-gage, indicating a rarefaction of 3000.

To one end of a glass tube, 2 inches diameter and 30 inches long, was fitted a brass cap and collar of leather, through which a wire was inserted, reaching about two inches within the tube. This was connected with the conductor of an electric machine. The other end was ground flat and set on the pump plate. When the gages indicated a rarefaction of 300, the light became steady and uniform, of a pale colour, though a little tinged with purple; at 600 the light was of a pale dusky white; when 1200 it disappeared in the middle of the tube, and the tube conducted so well that the prime conductor only gave sparks so faint and short as to be scarcely perceptible. After taking off the tube, and making it as dry as possible, it was again connected with the conductor, which was giving sparks two inches long. When the air in it was rarefied ten times, the sparks were of the same length. Sometimes a pencil of light darted along the tube. When the rarefaction was 20, the spark did not exceed an inch, and light streamed the whole length of the tube. When the rarefaction was 30, the sparks were half an inch, and the light rushed along the tube in great streams. When the rarefaction was 100, the sparks were about $\frac{1}{2}$ long, and the light filled the tube in an uninterrupted body. When 300, the appearances were as before. When 600, the sparks were $\frac{1}{10}$, and the light was of a faint white colour in the middle, but tinged with purple toward the ends. When 1200, the light was hardly perceptible in the middle, and was much fainter at the ends than before, but still ruddy. When 1400, which was the most the pump could produce, six inches

of the middle of the tube were quite dark, and the Air pump ends free of any tinge of red, and the sparks did not exceed $\frac{1}{8}$ of an inch.

158
We trust that our readers will not be displeased with the preceding history of the air-pump. The occasional information which it gives will be of great use to every person much engaged in pneumatic experiments, and help him in the contrivance and construction of the necessary apparatus. The best improvements of the air-pump have been made in Britain

We may be indulged in one remark, that although this noble instrument originated in Germany, all its improvements were made in this kingdom. Both the mechanical and pneumatic principles of Mr Boyle's construction were extremely different from the German, and, in respect of expedition and convenience, much superior. The double barrel and gage by Hawkesbee were capital improvements, and on principle; and Mr Smeaton's method of making the piston work in rarefied air made a complete change in the whole process.

159
Aided by this machine, we can make experiments establishing and illustrating the gravity and elasticity of the air in a much more perspicuous manner than could be done by the spontaneous phenomena of nature. Utility of the air-pump.

160
It allows us in the first place to show the materiality of air in a very distinct manner. Bodies cannot move about in the atmosphere without displacing it. This requires force; and the resistance of the air always diminishes the velocity of bodies moving in it. A heavy body therefore has the velocity of its fall diminished; and if the quantity of air displaced be very great, the diminution will be very considerable. This is the reason why light bodies, such as feathers, fall very slowly. Their moving force is very small, and can therefore displace a great quantity of air only with a very small velocity. But if the same body be dropped in *vacuo*, when there is no air to be displaced, it falls with the whole velocity competent to its gravity. Fig. 29. Plate CCCII. represents an apparatus by which a guinea and a downy feather are dropped at the same instant, by opening the forceps which holds them by means of the slip-wire in the top of the receiver. If this be done after the air has been pumped out, the guinea and the feather will be observed to reach the bottom at the same instant. Experiments to show the utility of the air-pump.

161
Fig. 30. represents another apparatus for showing the same thing. It consists of two sets of brass vanes put in separate axles, in the manner of windmill sails. One set has their edges placed in the direction of their whirling motion, that is, in a plane to which the axis is perpendicular. The planes of the other set pass through the axis, and they are therefore trimmed so as directly to front the air through which they move. Two springs act upon pins projecting from the axis; and their strength or tensions are so adjusted, that when they are disengaged in *vacuo*, the two sets continue in motion equally long. If they are disengaged in the air, the vanes which beat the air with their planes will stop long before those which cut it edgewise.

162
We can now abstract the air almost completely from a dry vessel, so as to know the precise weight of the air which filled it. The first experiment we have of this kind, done with accuracy, is that of Dr Hooke; Feb. 10. 1664, when he found 114 pints of air to weigh

Air pump. weigh 945 grains. One pint of water was $8\frac{7}{12}$ ounces. This gives for the specific gravity of air $\frac{1}{815}$ very nearly.

Th effect of the weight of the air immersed in Since we are thus immersed in a gravitating fluid, it follows, that every body preponderates only with the excess of its own weight above that of the air which it displaces; for every body loses by this immersion the weight of the displaced air. A cubic foot loses about 521 grains in frosty weather. We see balloons even rise in the air, as a piece of cork rises in water. A mass of water which really contains 850 pounds will load the scale of a balance with 849 only, and will be balanced by about $849\frac{1}{8}$ pounds of brass. This is evinced by a very pretty experiment, represented in fig. 31. A small beam is suspended within a receiver. To one end of the beam is appended a thin glass or copper ball, close in every part. This is balanced by a small piece of lead hung on the other arm. As the air is pumped out of the receiver, the ball will gradually preponderate, and will regain its equilibrium when the air is re-admitted.

ate CCII. Some naturalists have proposed, and actually used, a large globe of light make, suspended at a beam, for a barometer. If its capacity is a cubic foot, $1\frac{1}{10}$ grains will indicate the same change that is indicated by $\frac{1}{10}$ of an inch of an ordinary barometer. But a vessel of this size will load a balance too much to leave it sufficiently sensible to small changes of density. Besides, it is affected by heat and cold, and would require a very troublesome equation to correct their effects.

165 It may perhaps be worth while to attend to this in buying and selling precious commodities; such as pearls, diamonds, silk, and some drugs. As they are generally sold by brass or leaden weights, the buyer will have some advantage when the air is heavy and the barometer high. On the other hand, he will have the advantage in buying gold and mercury when the air is light. It is needless to confine this observation to precious commodities, for the advantage is the same in all in proportion to their levity.

166 There is a case in which this observation is of consequence to the philosopher: we mean the measuring of time by pendulums. As the accelerating force on a pendulum is not its whole weight, but the excess of its weight over that of the displaced air, it follows that a pendulum will vibrate more slowly in the air than *in vacuo*. A pendulum composed of lead, iron, and brass, may be about 8400 times heavier than the air which it displaces when the barometer is at 30 inches and the thermometer at 32° , and the accelerating force will be diminished about $\frac{1}{815}$. This will cause a second pendulum to make about five vibrations less in a day than it would do *in vacuo*. In order therefore to deduce the accelerative power of gravity from the length of a pendulum vibrating in the air, we must make an allowance of $0,17$, or $\frac{1}{585}$ of a second, per day for every inch that the barometer stands lower than 30 inches. But we must also note the temperature of the air; because when the air is warm it is less dense when supporting by its elasticity the same weight of atmosphere, and we must know how much its density is diminished by an increase of temperature. The correction is still more complicated; for the change of density affects the resistance of the air, and this affects the time of the vibration, and this by a law that is not yet well

ascertained. As far as we can determine from any experiments that have been made, it appears that the change arising from the altered resistance takes off about $\frac{2}{7}$ of the change produced by the altered density, and that a second pendulum makes but three vibrations a day more *in vacuo* than in the open air. This is a very unexpected result; but it must be owned that the experiments have neither been numerous nor very nicely made.

The air-pump also allows us to show the effects of the air's pressure in a great number of amusing and instructive phenomena.

167 When the air is abstracted from the receiver, it is strongly pressed to the pump-plate by the incumbent atmosphere, and it supports this great pressure in consequence of its circular form. Being equally compressed on all sides, there is no place where it should give way rather than another; but if it be thin, and not very round, which is sometimes the case, it will be crushed to pieces. If we take a square thin phial, and apply an exhausting syringe to its mouth, it will not fail being crushed.

As the operation of pumping is something like sucking, many of these phenomena are in common discourse ascribed to suction, a word much abused; and this abuse misleads the mind exceedingly in its contemplation of natural phenomena. Nothing is more usual than to speak of the suction of a syringe, the suction and draught of a chimney, &c. The following experiment puts the true cause of the strong adhesion of the receiver beyond a doubt.

Place a small receiver or cupping-glass on the pump-plate without covering the central hole, as represented in fig. 32. and cover it with a larger receiver. Exhaust the air from it; then admit it as suddenly as possible. The outer receiver, which after the rarefaction adhered strongly to the plate, is now loose, and the cupping-glass will be found sticking fast to it. While the rarefaction was going on, the air in the small receiver also expanded, escaped from it, and was abstracted by the pump. When the external air was suddenly admitted, it pressed on the small receiver, and forced it down to the plate, and thus shut up all entry. The small receiver must now adhere; and there can be no suction, for the pipe of the pump was on the outside of the cupping-glass.

This experiment sometimes does not succeed, because the air sometimes finds a passage under the brim of the cupping-glass. But if the cupping-glass be pressed down by the hand on the greasy leather or plate, every thing will be made smooth, and the glass will be so little raised by the expansion of its air during the pumping, that it will instantly clap close when the air is re-admitted.

In like manner, if a thin square phial be furnished with a valve, opening from within, but shutting when pressed from without, and if this phial be put under a receiver, and the air be abstracted from the receiver, the air in the phial will expand during the rarefaction, will escape through the valve, and be at last in a very rarefied state within the phial. If the air be now admitted into the receiver, it will press on the flat sides of the included phial and crush it to pieces. See fig. 33.

If a piece of wet ox-bladder be laid over the top of a receiver whose orifice is about four inches wide, and

Plate CCCLIII.

168

169

Air-pump

Plate
CCCCII.

the air be exhausted from within it, the incumbent atmosphere will press down the bladder into a hollow form, and then burst it inward with a prodigious noise. See fig. 34. Or if a piece of thin flat glass be laid over the receiver, with an oiled leather between them to make the juncture air-tight, the glass will be broken downwards. This must be done with caution, because the pieces of glass sometimes fly about with great force.

170

If there be formed two hemispherical cups of brass, with very flat thick brims, and one of them be fitted with a neck and stopcock, as represented by fig. 35. the air may be abstracted from them by screwing the neck into the hole in the pump-plate. To prevent the insinuation of air, a ring of oiled leather may be put between the rims. Now unscrew the sphere from the pump, and fix hooks to each, and suspend them from a strong nail, and hang a scale to the lowest. It will require a considerable weight to separate them; namely, about 15 pounds for every square inch of the great circle of the sphere. If this be four inches diameter, it will require near 190 pounds. This pretty experiment was first made by Otto Guericke, and on a very great scale. His sphere was of a large size, and, when exhausted, the hemispheres could not be drawn asunder by 20 horses. It was exhibited, along with many others equally curious and magnificent, to the Emperor of Germany and his court, at the breaking up of the diet of Ratisbon in 1654.

171

If the loaded syringe mentioned in n° 16. be suspended by its piston from the hook in the top plate of the receiver, as in fig. 36. and the air be abstracted by the pump, the syringe will gradually descend (because the elasticity of the air, which formerly balanced the pressure of the atmosphere, is now diminished by its expansion, and is therefore no longer able to press the syringe to the piston), and it will at last drop off. If the air be admitted before this happens, the syringe will immediately rise again.

172

Screw a short brass pipe into the neck of a transporter, n° 107. on which is set a tall receiver, and immerse it into a cistern of water. On opening the cork the pressure of the air on the surface of the water in the cistern will force it up through the pipe, and cause it to spout into the receiver with a strong jet, because there is no air within to balance by its elasticity the pressure of the atmosphere. See fig. 37.

173
By means of this pressure of an air-pump acts,

It is in the same way that the gage of the air-pump performs its office. The pressure of the atmosphere raises the mercury in the gage till the weight of the mercury, together with the remaining elasticity of the air in the receiver, are in equilibrio with the whole pressure of the atmosphere: therefore the height and weight of the mercury in the gage is the excess of the weight of the atmosphere above the elasticity of the included air; and the deficiency of this height from that of the mercury in the Toricellian tube is the measure of this remaining elasticity.

174

If a Toricellian tube be put under a tall receiver, as shown in fig. 38. and the air be exhausted, the mercury in the tube will descend while that in the gage will rise; and the sum of their heights will always be the same, that is, equal to the height in an ordinary barometer. The height of the mercury in the receiver is the effect and measure of the remaining elasticity of the included air, and the height in the pump-gage is the unbalanced

pressure of the atmosphere. This is a very instructive Air pump experiment, perfectly similar to Mr Auzout's, mentioned in n° 34. and completely establishes and illustrates the whole doctrine of atmospheric pressure.

We get a similar illustration and confirmation (if ¹⁷⁵ such a thing be now needed) of the cause of the rise of ^{Water rise} in pumps, by screwing a syringe into the top plate of a receiver, which syringe has a short glass pipe plunging into a small cup of water. See fig. 39. When the piston-rod is drawn up, the water rises in the glass pipe, as in any other pump, of which this is a miniature representation. But if the air has been previously exhausted from the receiver, there is nothing to press on the water in the little jar; and it will not rise in the glass pipe though the piston of the syringe be drawn to the top.

Analogous to the rise of water in pumps is its rise ¹⁷⁶ and motion in syphons. Suppose a pipe ABCD, fig. 40. ^{in syphon} bent at right angles at B and C, and having its two ends immersed in the cisterns of water A and D. Let the leg CD be longer than the leg BA, and let the whole be full of water. The water is pressed upwards at A with a force equal to the weight of the column of air EA reaching to the top of the atmosphere; but it is pressed downwards by the weight of the column of water BA. The water at E is pressed downwards by the weight of the column CD, and upwards by the weight of the column of air FD reaching to the top of the atmosphere. The two columns of air differ very little in their weight, and may without any sensible error be considered as equal. Therefore there is a superiority of pressure downwards at D, and the water will flow out there. The pressure of the air will raise the water in the leg AB, and thus the stream will be kept up till the vessel A is emptied as low as the orifice of the leg BA, provided the height of AB is not greater than what the pressure of the atmosphere can balance, that is, does not exceed 32 or 33 feet for water, 30 inches for mercury, &c.

A syphon then will always run from that vessel whose surface is highest; the form of the pipe is indifferent, because the hydrostatical pressures depend on the vertical height only. It must be filled with water by some other contrivance, such as a funnel, or a pump applied a-top; and the funnel must be stopped up, otherwise the air would get in, and the water would fall in both legs.

If the syphon have equal legs, as in fig. 41. and be ¹⁷⁷ turned up at the ends, it will remain full of water, and be ready for use. It need only be dipped into any vessel of water, and the water will then flow out at the other end of the syphon. This is called the *Wirtinberg syphon*, and is represented in fig. 41. Syphons will afterwards be considered more minutely under the title of *PNEUMATICAL Engines*, at the end of this article.

What is called the *syphon fountain*, constructed on this ¹⁷⁸ principle, is shown in fig. 42. where AB is a tall receiver, standing in a wide basin DE, which is supported on the pedestal H by the hollow pillar FG. In the centre of the receiver is a jet pipe C, and in the top a ground stopper A. Near the base of the pillar is a cock N, and in the pedestal is another cock O.

Fill the basin DE with water within half an inch of the brim. Then pour in water at the top of the receiver (the cock N being shut) till it is about half full, ¹⁷⁹ and

series
on
A, &c.

and then put in the stopper. A little water will run out into the vessel DE. But before it runs over, open the cock N, and the water will run into the cistern H; and by the time that the pipe C appears above water, a jet will rise from it, and continue as long as water is supplied from the basin DE. The passage into the base cistern may be so tempered by the cock N that the water within the receiver shall keep at the same height, and what runs into the basin may be received from the cock O into another vessel, and returned into DE, to keep up the stream.

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plate
CCCCIII.

This pretty philosophical toy may be constructed in the following manner. BB, fig. 42. n° 2. is the ferul or cap into which the receiver is cemented. From its centre descends the jet pipe Ca, sloping outwards, to give room for the discharging pipe bd of larger diameter, whose lower extremity d fits tightly into the top of the hollow pillar FG.

The operation of the toy is easily understood. Suppose the distance from C to H (n° 1.) three feet, which is about $\frac{1}{10}$ of the height at which the atmosphere would support a column of water. The water poured into AB would descend through FG (the hole A being shut) till the air has expanded $\frac{1}{10}$, and then it would stop. If the pipe Ca be now opened, the pressure of the air on the surface of the water in the cistern DE will cause it to spout through C to the height of three feet nearly, and the water will continue to descend through the pipe FG. By tempering the cock N so as to allow the water to pass through it as fast as it is supplied by the jet, the amusement may be continued a long time. It will stop at last, however; because, as the jet is made into rarefied air, a little air will be extricated from the water, which will gradually accumulate in the receiver, and diminish its rarefaction, which is the moving cause of the jet. This indeed is an inconvenience felt in every employment of syphons, so much the more remarkably as their top is higher than the surface of the water in the cistern of supply.

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Cases of this employment of a syphon are not unfrequent. When water collected at A (fig. 43.) is to be conducted in a pipe to C, situated in a lower part of the country, it sometimes happens, as between Lochend and Leith, that the intervening ground is higher than the fountain-head as at B. A forcing pump is erected at A, and the water forced along the pipe. Once it runs out at C, the pump may be removed, and the water will continue to run on the syphon principle, provided BD do not exceed 33 feet. But the water in that part of the conduit which is above the horizontal plane AD, is in the same state as in a receiver of rarefied air, and gives out some of the air which is chemically united with it. This gradually accumulates in the elevated part of the conduit, and at last chokes it entirely. When this happens, the forcing pump must again be worked. Although the elevation in the Leith conduit is only about eight or ten feet, it will seldom run for 12 hours. N. B. This air cannot be discharged by the usual air-cocks; for if there were an opening at B, the air would rush in, and immediately stop the motion.

181
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This combination of air with water is very distinctly seen by means of the air-pump. If a small glass containing cold water, fresh drawn from the spring, be exposed, as in fig. 44. under the receiver, and the air

rarefied, small bubbles will be observed to form on the inner surface of the glass, or on the surface of any body immersed in it, which will increase in size, and then detach themselves from the glass and reach the top; as the rarefaction advances, the whole water begins to show very minute air-bubbles rising to the top; and this appearance will continue for a very long time, till it be completely disengaged. Warming the water will occasion a still farther separation of air, and a boiling heat will separate all that can be disengaged. The reason assigned for these air-bubbles first appearing on the surface of the glass, &c. is, that air is attracted by bodies, and adheres to their surface. This may be so. But it is more probably owing to the attraction of the water for the glass, which causes it to quit the air which it held in solution, in the same manner as we see it happen when it is mixed with spirits-of-wine, with vitriolic acid, &c. or when salts or sugar are dissolved in it. For if we pour out the water which has been purged of air by boiling in *vacuo*, and fill the glass with fresh water, we shall observe the same thing, although a film of the purified water was left adhering to the glass. In this case there can be no air adhering to the glass.

Elasticity,
&c.
Plate
CCCCIV.

Water thus purged of air by boiling (or even without boiling) in *vacuo*, will again absorb air when exposed to the atmosphere. The best demonstration of this is to fill with this water a phial, leaving about the size of a pea not filled. Immerse this in a vessel of water, with the mouth undermost, by which means the air-bubble will mount up to the bottom of the phial. After some days standing in this condition, the air-bubble will be completely absorbed, and the vessel quite filled with water.

182

The air in this state of chemical solution has lost its elasticity, for the water is not more compressible than common water. It is also found that water brought up from a great depth under ground contains much more air than water at the surface. Indeed fountain waters differ exceedingly in this respect. The water which now comes into the city of Edinburgh by pipes contains so much as to throw it into a considerable ebullition in *vacuo*. Other liquors contain much greater quantities of elastic fluids in this loosely combined state. A glass of beer treated in the same way will be almost wholly converted into froth by the escape of its fixed air, and will have lost entirely the prickling smartness which is so agreeable, and it becomes quite vapid.

183

The air-pump gives us, in the next place, a great variety of experiments illustrative of the air's elasticity and expansibility. The very operation of exhaustion, as it is called, is an instance of its great, and hitherto un-
limited, expansibility. But this is not palpably exhibited to view. The following experiments show it most distinctly.

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sibility.

1st, Put a flaccid bladder, of which the neck is firmly tied with a thread, under a receiver, and work the pump. The bladder will gradually swell, and will even be fully distended. Upon readmitting the air into the receiver, the bladder gradually collapses again into its former dimensions: while the bladder is flaccid, the air within it is of the same density and elasticity with the surrounding air, and its elasticity balances the pressure of the atmosphere. When part of the air of the receiver is abstracted, the remainder expands so

184

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as still to fill the receiver; but by expanding, its elasticity is plainly diminished; for we see by the fact, that the elasticity of the air of the receiver no longer balances the elasticity of that in the bladder, as it no longer keeps it in its dimensions. The air in the bladder expands also: it expands till its diminished elasticity is again in equilibrio with the diminished elasticity of the air in the receiver; that is, till its density is the same. When all the wrinkles of the bladder have disappeared, its air can expand no more, although we continue to diminish the elasticity of the air of the receiver by further rarefaction. The bladder now tends to burst; and if it be pierced by a point or knife fastened to the slip-wire, the air will rush out, and the mercury descend rapidly in the gage.

185

If a phial or tube be partly filled with water, and immersed in a vessel of water with the mouth downwards, the air will occupy the upper part of the phial. If this apparatus be put under a receiver, and the air be abstracted, the air in the phial will gradually expand, allowing the water to run out by its weight till the surface of the water be on a level within and without. When this is the case, we must grant that the density and elasticity of the air in the phial is the same with that in the receiver. When we work the pump again, we shall observe the air in the phial expand still more, and come out of the water in bubbles. Continuing the operation, we shall see the air continually escaping from the phial: when this is over, it shows that the pump can rarefy no more. If we now admit the air into the receiver, we shall see the water rise into the phial, and at last almost completely fill it, leaving only a very small bubble of air at top. This bubble had expanded so as to fill the whole phial. See this represented in fig. 45.

Plate
CCCCIV.
186

Every one must have observed a cavity at the big end of an egg between the shell and the white. The white and yolk are contained in a thin membrane or bladder which adheres loosely to the shell, but is detached from it at that part; and this cavity increases by keeping the egg in a dry place. One may form a judgment of its size, and therefore of the freshness of the egg, by touching it with the tongue; for the shell, where it is not in contact with the contents, will presently feel warm, being quickly heated by the tongue, while the rest of the egg will feel cold.

If a hole be made in the opposite end of the egg, and it be set on a little tripod, and put under a receiver, the expansion of the air in the cavity of the egg will force the contents through the hole till the egg be quite emptied: or, if nearly one half of the egg be taken away at the other end, and the white and yolk taken out, and the shell be put under a receiver, and the air abstracted, the air in the cavity of the egg will expand, gradually detaching the membrane from the shell, till it causes it to swell out, and gives the whole the appearance of an entire egg.—In like manner shrivelled apples and other fruits will swell in vacuo by the expansion of the air confined in their cavities.

187

If a piece of wood, a twig with green leaves, charcoal, plaster of Paris, &c. be kept under water in vacuo, a prodigious quantity of air will be extracted; and if we readmit the air into the receiver, it will force the water into the pores of the body. In this case the body will not swim in water as it did before, showing that the vegetable fibres are specifically heavier than water. It

is found, however, that the air contained in the pith and bark, such as cork, is not all extricated in this way; and that much of it is contained in vesicles which have no outlet: being secreted into them in the process of vegetation, as it is secreted into the air-bladder of fishes, where it is generally found in a pretty compressed state, considerably denser than the surrounding air. The air-bladder of a fish is surrounded by circular and longitudinal muscles, by which the fish can compress the air still further; and, by ceasing to act with them, allow it to swell out again. It is in this manner that the fish can suit its specific gravity to its situation in the water, so as to have no tendency either to rise or sink: but if the fish be put into the receiver of an air-pump, the rarefaction of the air obliges the fish to act more strongly with these contracting muscles, in order to adjust its specific gravity; and if too much air has been abstracted from the receiver, the fish is no longer able to keep its air-bladder in the proper degree of compression. It becomes therefore too buoyant, and comes to the top of the water, and is obliged to struggle with its tail and fins in order to get down; frequently in vain. The air-bladder sometimes bursts, and the fish goes to the bottom, and can no longer keep above without the continual action of its tail and fins. When fishes die, they commonly float at top, their contractive action being now at an end. All this may be illustrated (but very imperfectly) by a small half-blown bladder, to which is appended a bit of lead, just so heavy as to make it sink in water: when this is put under a receiver, and the air abstracted, the bubble will rise to the top; and, by nicely adjusting the rarefaction, it may be kept at any height. See fig. 46.

The play-things called *Cartesian devils* are similar to this: they are hollow glass figures, having a small aperture in the lower part of the figures, as at the point of the foot; their weight is adjusted so that they swim upright in water. When put into a tall jar filled to the top, and having a piece of leather tied over it, they will sink in the water, by pressing on the leather with the ball of the hand: this, by compressing the water, forces some of it to enter into the figure and makes it heavier than the water; for which reason it sinks, but rises again on removing the pressure of the hand. See fig. 47, n^o 1. and 2.

If a half-blown ox-bladder be put into a box, and great weights laid on it, and the whole be put under a receiver, and the air abstracted; the air will, by expanding, lift up the weights, though above an hundred pounds. See fig. 48.

By such experiments the great expansibility of the air is abundantly illustrated, as its compressibility was formerly by means of the condensing syringe. We now see that the two sets of experiments form an uninterrupted chain; and that there is no particular state of the air's density where the compressibility and expansibility is remarkably dissimilar. Air in its ordinary state expands; because its ordinary state is a state of compression by the weight of the atmosphere: and if there were a pit about 33 miles deep, the air at the bottom would probably be as dense as water; and if it were 50 miles deep, it would be as dense as gold, if it did not become a liquid before this depth: nay, if a bottle with its mouth undermost were immersed six miles under water, it would probably be as dense as water; we say probably, for this depends on the nature of its compressibility.

188

189

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sibility; that is, on the relation which subsists between the compression and the force which produces it.

This is the circumstance of its constitution, which we now proceed to examine; and it is evidently a very important circumstance. We have long ago observed, that the great compressibility and permanent fluidity of air, observed in a vast variety of phenomena, is totally inexplicable, on the supposition that the particles of air are like so many balls of sponge or so many foot-balls. Give to those what compressibility you please, common air could no more be fluid than a mass of clay; it could no more be fluid than a mass of such balls pressed into a box. It can be demonstrated (and indeed hardly needs a demonstration), that before a parcel of such balls, just touching each other, can be squeezed into half their present dimensions, their globular shape will be entirely gone, and each will have become a perfect cube, touching six other cubes with its whole surface; and these cubes will be strongly compressed together, so that motion could never be performed through among them by any solid body without a very great force. Whereas we know that in this state air is just as permeable to every body as the common air that we breathe. There is no way in which we can represent this fluidity to our imagination but by conceiving air to consist of particles, not only discrete, but distant from each other, and actuated by repulsive forces, or something analogous to them. It is an idle subterfuge, to which some naturalists have recourse, saying, that they are kept asunder by an intervening ether, or elastic fluid of any other name. This is only removing the difficulty a step farther off: for the elasticity of this fluid requires the same explanation; and therefore it is necessary, in obedience to the rules of just reasoning, to begin the inquiry here; that is, to determine from the phenomena what is the analogy between the distances of the particles and the repulsive forces exerted at these distances, proceeding in the same way as in the examination of planetary gravitation. We shall learn the analogy by attending to the analogy between the compressing force and the density.

191
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For the density depends on the distance between the particles; the nearer they are to each other, the denser is the air. Suppose a square pipe one inch wide and eight inches long, shut at one end, and filled with common air; then suppose a plug so nicely fitted to this pipe that no air can pass by it sides; suppose this piston thrust down to within an inch of the bottom: it is evident that the air which formerly filled the whole pipe now occupies the space of one cubic inch, which contains the same number of particles as were formerly diffused over eight cubic inches.

The condensation would have been the same if the air which fills a cube whose side is two inches had been squeezed into a cube of one inch, for the cube of two inches also contains eight inches. Now, in this case it is evident that the distance between the particles would be reduced to its half in every direction. In like manner, if a cube whose side is three inches, and which therefore contains 27 inches, be squeezed into one inch, the distance of the particles will be one third of what it was: in general the distance of the particles will be as the cube-root of the space into which they are compressed. If the space be $\frac{1}{8}, \frac{1}{27}, \frac{1}{64}, \frac{1}{125}, \frac{1}{216}, \frac{1}{343}, \frac{1}{512}, \frac{1}{729}, \frac{1}{1000}, \frac{1}{1331}, \frac{1}{1728}, \frac{1}{2197}, \frac{1}{2744}, \frac{1}{3375}, \frac{1}{4096}, \frac{1}{4913}, \frac{1}{5832}, \frac{1}{6859}, \frac{1}{8000}, \frac{1}{9261}, \frac{1}{10648}, \frac{1}{12167}, \frac{1}{13824}, \frac{1}{15625}, \frac{1}{17664}, \frac{1}{19843}, \frac{1}{22171}, \frac{1}{24760}, \frac{1}{27619}, \frac{1}{30768}, \frac{1}{34227}, \frac{1}{38016}, \frac{1}{42155}, \frac{1}{46664}, \frac{1}{51563}, \frac{1}{56882}, \frac{1}{62641}, \frac{1}{68860}, \frac{1}{75569}, \frac{1}{82798}, \frac{1}{90577}, \frac{1}{98926}, \frac{1}{107875}, \frac{1}{117464}, \frac{1}{127733}, \frac{1}{138712}, \frac{1}{150441}, \frac{1}{162960}, \frac{1}{176319}, \frac{1}{190568}, \frac{1}{205757}, \frac{1}{221936}, \frac{1}{239155}, \frac{1}{257464}, \frac{1}{276923}, \frac{1}{297592}, \frac{1}{319521}, \frac{1}{342860}, \frac{1}{367659}, \frac{1}{393968}, \frac{1}{421847}, \frac{1}{451346}, \frac{1}{482535}, \frac{1}{515474}, \frac{1}{550223}, \frac{1}{586842}, \frac{1}{625391}, \frac{1}{665930}, \frac{1}{708529}, \frac{1}{753248}, \frac{1}{799147}, \frac{1}{846296}, \frac{1}{894755}, \frac{1}{944594}, \frac{1}{995883}, \frac{1}{1048692}, \frac{1}{1103081}, \frac{1}{1159120}, \frac{1}{1216879}, \frac{1}{1276428}, \frac{1}{1337847}, \frac{1}{1399206}, \frac{1}{1462585}, \frac{1}{1527964}, \frac{1}{1595413}, \frac{1}{1664912}, \frac{1}{1736441}, \frac{1}{1809080}, \frac{1}{1882909}, \frac{1}{1958918}, \frac{1}{2036187}, \frac{1}{2114706}, \frac{1}{2194465}, \frac{1}{2275454}, \frac{1}{2357673}, \frac{1}{2441112}, \frac{1}{2525871}, \frac{1}{2611940}, \frac{1}{2699319}, \frac{1}{2787998}, \frac{1}{2877977}, \frac{1}{2969256}, \frac{1}{3061835}, \frac{1}{3155714}, \frac{1}{3250893}, \frac{1}{3347372}, \frac{1}{3445151}, \frac{1}{3544230}, \frac{1}{3644609}, \frac{1}{3746288}, \frac{1}{3849267}, 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\frac{1}{212645921}, \frac{1}{213092340}, \frac{1}{213538759}, \frac{1}{213985178}, \frac{1}{214431597}, \frac{1}{214878016}, \frac{1}{215324435}, \frac{1}{215770854}, \frac{1}{216217273}, \frac{1}{216663692}, \frac{1}{217109111}, \frac{1}{217555530}, \frac{1}{218001949}, \frac{1}{218448368}, \frac{1}{218894787}, \frac{1}{219341206}, \frac{1}{219787625}, \frac{1}{220234044}, \frac{1}{220680463}, \frac{1}{221126882}, \frac{1}{221573301}, \frac{1}{222019720}, \frac{1}{222466139}, \frac{1}{222912558}, \frac{1}{223358977}, \frac{1}{223805396}, \frac{1}{224251815}, \frac{1}{224698234}, \frac{1}{225144653}, \frac{1}{225591072}, \frac{1}{226037491}, \frac{1}{226483910}, \frac{1}{226930329}, \frac{1}{227376748}, \frac{1}{227823167}, \frac{1}{228269586}, \frac{1}{228715905}, \frac{1}{229162324}, \frac{1}{229608743}, \frac{1}{230055162}, \frac{1}{230501581}, \frac{1}{230947900}, \frac{1}{231394319}, \frac{1}{231840738}, \frac{1}{232287157}, \frac{1}{232733576}, \frac{1}{233179995}, \frac{1}{233626414}, \frac{1}{234072833}, \frac{1}{234519252}, \frac{1}{234965671}, \frac{1}{235412090}, \frac{1}{235858509}, \frac{1}{236304928}, \frac{1}{236751347}, \frac{1}{237197766}, \frac{1}{237644185}, \frac{1}{238090604}, \frac{1}{238537023}, \frac{1}{238983442}, \frac{1}{239429861}, \frac{1}{239876280}, \frac{1}{240322699}, \frac{1}{240769118}, \frac{1}{241215537}, \frac{1}{241661956}, \frac{1}{242$

1st Set.		2d Set.		3d Set.	
D	E	D	E	D	E
1,000	1,000	1,000	1,000	1,000	1,000
1,100	1,093	1,236	1,224	1,091	1,076
1,222	1,211	1,294	1,288	1,200	1,183
1,375	1,284	1,375	1,332	1,333	1,303
1,571	1,559	1,466	1,414	1,500	1,472
1,692	1,660	1,571	1,515	1,714	1,659
1,833	1,796	1,692	1,647		
2,000	1,958	2,000	1,964	2,000	1,900
2,288	2,130				
2,444	2,375	2,444	2,392	2,400	2,241
3,143	2,936	3,143	3,078	3,000	2,793
3,666	3,391	3,666	3,575		
4,000	3,706			4,000	3,631
4,444	4,035	4,444	4,320		
4,888	4,433				
5,500	4,922	5,500	5,096		
5,882	5,522			6,000	5,297
		7,333	6,694		
				8,000	6,835

There appears in these experiments sufficient grounds for calling in question the Boylean law; and the writer of this article thought it incumbent on him to repeat them with some precautions, which probably had not been attended to by Mr Sulzer. He was particularly anxious to have the air as free as possible from moisture. For this purpose, having detached the short leg of the syphon, which was 34 inches long, he boiled mercury in it, and filled it with mercury boiling hot. He took a tinplate vessel of sufficient capacity, and put into it a quantity of powdered quicklime just taken from the kiln; and having closed the mouth, he agitated the lime through the air in the vessel, and allowed it to remain there all night. He then emptied the mercury out of the syphon into this vessel, keeping the open end far within it. By this means the short leg of the syphon was filled with very dry air. The other part was now joined, and boiled mercury put into the bend of the syphon; and the experiment was then prosecuted with mercury which had been recently boiled, and was the same with which the barometer had been carefully filled.

The results of the experiments are expressed in the following table.

Dry Air.		Moist Air.		Camp. Air.	
D	E	D	E	D	E
1,000	1,000	1,000	1,000	1,000	1,000
2,000	1,957	2,000	1,920	2,000	1,909
3,000	2,848	3,000	2,839	3,000	2,845
4,000	3,737	4,000	3,726	4,000	3,718
5,500	4,930	5,500	5,000	5,500	5,104
6,000	5,342	6,000	5,452	6,000	5,463
7,620	6,490	7,620	6,775	7,620	6,812

Here it appears again in the clearest manner that the elasticities do not increase as fast as the densities, and the differences are even greater than in Mr Sulzer's experiments.

The second table contains the results of experiments

made on very damp air in a warm summer's morning. Elasticity. In these it appears that the elasticities are almost precisely proportional to the densities + a small constant quantity, nearly 0,11 deviating from this rule chiefly between the densities 1 and 1,5, within which limits we have very nearly $D = E^{1.0017}$. As this air is nearer to the constitution of atmospheric air than the former, this rule may be safely followed in cases where atmospheric air is concerned, as in measuring the depths of pits by the barometer.

The third table shows the compression and elasticity of air strongly impregnated with the vapours of camphire. Here the Boylean law appears pretty exact, or rather the elasticity seems to increase a little faster than the density.

Dr Hooke examined the compression of air by immersing a bottle to great depths in the sea, and weighing the water which got into it without any escape of air. But this method was liable to great uncertainty, on account of the unknown temperature of the sea at great depths.

Hitherto we have considered only such air as is not rarer than what we breathe; we must take a very different method for examining the elasticity of rarefied air.

Let $g b$ (fig. 50.) be a long tube, formed a-top into a cup, and of sufficient diameter to receive another smaller tube $a f$, open at first at both ends. Let the outer tube and cup be filled with mercury, which will rise in the inner tube to the same level. Let $a f$ now be stopped at a . It contains air of the same density and elasticity with the adjoining atmosphere. Note exactly the space $a b$ which it occupies. Draw it up into the position of fig. 51. and let the mercury stand in it at the height $d e$, while $c e$ is the height of the mercury in the barometer. It is evident that the column $d e$ is in equilibrio between the pressure of the atmosphere and the elasticity of the air included in the space $a d$. And since the weight of $c e$ would be in equilibrio with the whole pressure of the atmosphere, the weight of $c d$ is equivalent to the elasticity of the included air. While therefore $c e$ is the measure of the elasticity of the surrounding atmosphere, $c d$ will be the measure of the elasticity of the included air; and since the air originally occupied the space $a b$, and has now expanded into $a d$, we have $\frac{a b}{a d}$ for the measure of its density. N. B.

$c e$ and $c d$ are measured by the perpendicular heights of the columns, but $a b$ and $a d$ must be measured by their solid capacities.

By raising the inner tube still higher, the mercury will also rise higher, and the included air will expand still farther, and we obtain another $c d$, and another $\frac{a b}{a d}$; and in this manner the relation between the density and elasticity of rarefied air may be discovered.

This examination may be managed more easily by means of the air-pump. Suppose a tube $a c$ (fig. 52.) containing a small quantity of air $a b$, set up in a cistern of mercury, which is supported in the tube at the height $e b$, and let $c c$ be the height of the mercury in the barometer. Let this apparatus be set under a tubulated receiver on the pump-plate, and let $g n$ be the pump-gage, and $m n$ be made equal to $c c$.

Then,

Experi-
ments on
Air.

Then, as has been already shown, ab is the measure of the elasticity of the air in ab , corresponding to the bulk ab . Now let some air be abstracted from the receiver. The elasticity of the remainder will be diminished by its expansion; and therefore the mercury in the tube ae will descend to some point d . For the same reason, the mercury in the gage will rise to some point o , and mo will express the elasticity of the air in the receiver. This would support the mercury in the tube ae at the height er , if the space ar were entirely void of air. Therefore rd is the effect and measure of the elasticity of the included air when it has expanded to the bulk ad ; and thus its elasticity, under a variety of other bulks, may be compared with its elasticity when of the bulk ab . When the air has been so far abstracted from the receiver that the mercury in ae descends to e , then mo will be the precise measure of its elasticity.

In all these cases it is necessary to compare its bulk ab with its natural bulk, in which its elasticity balances the pressure of the atmosphere. This may be done by laying the tube ae horizontally, and then the air will collapse into its ordinary bulk.

209
Another
easy me-
thod
Plate
CCCCIV.

Another easy method may be taken for this examination. Let an apparatus $abcdef$ (fig. 52.) be made, consisting of a horizontal tube ae of even bore, a ball dge of a large diameter, and a swan-neck tube bf . Let the ball and part of the tube geb be filled with mercury, so that the tube may be in the same horizontal plane with the surface de of the mercury in the ball. Then seal up the end a , and connect f with an air-pump. When the air is abstracted from the surface de , the air in ab will expand into a larger bulk ac , and the mercury in the pump-gage will rise to some distance below the barometric height. It is evident that this distance, without any farther calculation, will be the measure of the elasticity of the air pressing on the surface de , and therefore of the air in ac .

210
The most
exact mode
of examin-
ing this
elasticity.

The most exact of all methods is to suspend in the receiver of an air-pump a glass vessel, having a very narrow mouth over a cistern of mercury, and then abstract the air till the gage rises to some determined height. The difference e between this height and the barometric height determines the elasticity of the air in the receiver and in the suspended vessel. Now lower down that vessel by the slip-wire till its mouth is immersed into the mercury, and admit the air into the receiver; it will press the mercury into the little vessel. Lower it still farther down, till the mercury within it is level with that without; then stop its mouth, take it out and weigh the mercury, and let its weight be w . Subtract this weight from the weight v of the mercury, which would completely fill the whole vessel; then the natural bulk of the air will be $v - w$, while its bulk, when of the elasticity e in the rarefied receiver, was the bulk or capacity av of the vessel. Its density therefore, corresponding to this elasticity e , was $\frac{v-w}{w}$.

And thus may the relation between the density and elasticity in all cases be obtained.

211
Various ex-
periments
have been
made to
this pur-
pose.

A great variety of experiments to this purpose have been made, with different degrees of attention, according to the interest which the philosophers had in the result. Those made by M. de Luc, General Roy, Mr Trembley, and Sir George Shuckbrough, are by far

the most accurate; but they are all confined to very moderate rarefactions. The general result has been, that the elasticity of rarefied air is very nearly proportional to its density. We cannot say with confidence that any regular deviation from this law has been observed, there being as many observations on one side as on the other; but we think that it is not unworthy the attention of philosophers to determine it with precision in the cases of extreme rarefaction, where the irregularities are most remarkable. The great source of error is a certain adhesive sluggishness of the mercury when the impelling forces are very small; and other fluids can hardly be used, because they either smear the inside of the tube and diminish its capacity, or they are converted into vapour, which alters the law of elasticity.

Let us, upon the whole, assume the Boylean law, viz. that the elasticity of the air is proportional to its density. The law deviates not in any sensible degree from the truth in those cases which are of the greatest practical importance, that is, when the density does not much exceed or fall short of that of ordinary air.

Let us now see what information this gives us with respect to the action of the particles on each other.

The investigation is extremely easy. We have seen that a force eight times greater than the pressure of the atmosphere will compress common air into the eighth part of its common bulk, and give it eight times its common density: and in this case we know, that the particles are at half their former distance, and that the number which are now acting on the surface of the piston employed to compress them is quadruple of the number which act on it when it is of the common density. Therefore, when this eightfold compressing force is distributed over a fourfold number of particles, the portion of it which acts on each is double. In like manner, when a compressing force 27 is employed, the air is compressed into $\frac{1}{27}$ of its former bulk, the particles are at $\frac{1}{3}$ of their former distance, and the force is distributed among 9 times the number of particles; the force on each is therefore 3. In short, let $\frac{1}{x}$ be the

distance of the particles, the number of them in any given vessel, and therefore the density will be as x^3 , and the number pressing by their elasticity on its whole internal surface will be as x^2 . Experiment shows, that the compressing force is as x^3 , which being distributed over the number as x^3 , will give the force on each as x . Now this force is in immediate equilibrium with the elasticity of the particle immediately contiguous to the compressing surface. This elasticity is therefore as x : and it follows from the nature of perfect fluidity, that the particle adjoining to the compressing surface presses with an equal force on its adjoining particles on every side. Hence we must conclude, that the corpuscular repulsions exerted by the adjoining particles are inversely as their distances from each other, or that the adjoining particles tend to recede from each other with forces inversely proportional to their distances.

Sir Isaac Newton was the first who reasoned in this manner from the phenomena. Indeed he was the first who had the patience to reflect on the phenomena with any precision. His discoveries in gravitation naturally gave his thoughts this turn, and he very early hinted his suspicions that all the characteristic phenomena of the tangible

tangible matter were produced by forces which were exerted by the particles at small and insensible distances: And he considers the phenomena of air as affording an excellent example of this investigation, and deduces from them the law which we have now demonstrated; and says, that air consists of particles which avoid the adjoining particles with forces inversely proportional to their distances from each other. From this he deduces (in the 2d book of his Principles) several beautiful propositions, determining the mechanical constitution of the atmosphere.

But it must be noticed that he limits this action to the adjoining particles: and this is a remark of immense consequence, though not attended to by the numerous experimenters who adopt the law.

It is plain that the particles are supposed to act at a distance, and that this distance is variable, and that the forces diminish as the distances increase. A very ordinary air-pump will rarefy the air 125 times. The distance of the particles is now 5 times greater than before; and yet they still repel each other: for air of this density will still support the mercury in a syphon-gage at the height of 0,24, or $\frac{24}{100}$ of an inch; and a better

pump will allow this air to expand twice as much, and still leave it elastic. Thus we see that whatever is the distance of the particles of common air, they can act five times farther off. The question comes now to be, Whether, in the state of common air, they really do act five times farther than the distance of the adjoining particles? While the particle *a* acts on the particle *b* with the force 5, does it also act on the particle *c* with the force 2,5, on the particle *d* with the force 1,667, on the particle *e* with the force 1,25, on the particle *f* with the force 1, on the particle *g* with the force 0,8333, &c?

Sir Isaac Newton shows in the plainest manner, that this is by no means the case; for if this were the case, he makes it appear that the sensible phenomena of condensation would be totally different from what we observe. The force necessary for a quadruple condensation would be eight times greater, and for a nonuple condensation the force must be 27 times greater. Two spheres filled with condensed air must repel each other, and two spheres containing air that is rarer than the surrounding air must attract each other, &c. &c. All this will appear very clearly, by applying to air the reasoning which Sir Isaac Newton has employed in deducing the sensible law of mutual tendency of two spheres, which consist of particles attracting each other with forces proportional to the square of the distance inversely.

If we could suppose that the particles of air repelled each other with invariable forces at all distances within some small and insensible limit, this would produce a compressibility and elasticity similar to what we observe. For if we consider a row of particles, within this limit, as compressed by an external force applied to the two extremities, the action of the whole row on the extreme points would be proportional to the number of particles, that is, to their distance inversely and to their density: and a number of such parcels, ranged in a straight line, would constitute a row of any sensible magnitude having the same law of compression. But this law of corpuscular force is unlike every thing we observe in nature, and to the last degree improbable.

We must therefore continue the limitation of this mutual repulsion of the particles of air, and be contented for the present with having established it as an experimental fact, that the adjoining particles of air are kept asunder by forces inversely proportional to their distances; or perhaps it is better to abide by the sensible law, that the density of air is proportional to the compressing force. This law is abundantly sufficient for explaining all the subordinate phenomena, and for giving us a complete knowledge of the mechanical constitution of our atmosphere.

And, in the first place, this view of the compressibility of the air must give us a very different notion of the height of the atmosphere from what we deduced on a former occasion from our experiments. It is found, that when the air is of the temperature 32° of Fahrenheit's thermometer, and the mercury in the barometer stands at 30 inches, it will descend one-tenth of an inch if we take it to a place 87 feet higher. Therefore, if the air were equally dense and heavy throughout, the height of the atmosphere would be $30 \times 10 \times 87$ feet, or 5 miles and 100 yards. But the loose reasoning adduced on that occasion was enough to show us that it must be much higher; because every stratum as we ascend must be successively rarer as it is less compressed by incumbent weight. Not knowing to what degree air expanded when the compression was diminished, we could not tell the successive diminutions of density and consequent augmentation of bulk and height; we could only say, that several atmospheric appearances indicated a much greater height. Clouds have been seen much higher; but the phenomenon of the twilight is the most convincing proof of this. There is no doubt that the visibility of the sky or air is owing to its want of perfect transparency, each particle (whether of matter purely aerial or heterogeneous) reflecting a little light.

Let *b* (fig. 54.) be the last particle of illuminated air which can be seen in the horizon by a spectator at *A*. This must be illuminated by a ray *SDb*, touching the earth's surface at some point *D*. Now it is a known fact, that the degree of illumination called twilight is perceived when the sun is 18° below the horizon of the spectator, that is, when the angle *E b S* or *ACD* is 18 degrees; therefore *b C* is the secant of 9 degrees (it is less, viz. about 8½ degrees, on account of refraction). We know the earth's radius to be about 3970 miles: hence we conclude *b B* to be about 45 miles; nay, a very sensible illumination is perceptible much farther from the sun's place than this, perhaps twice as far, and the air is sufficiently dense for reflecting a sensible light at the height of nearly 200 miles.

We have now seen that air is prodigiously expandible. None of our experiments have distinctly shown us any limit. But it does not follow that it is expandible without end; nor is this at all likely. It is much more probable that there is a certain distance of the parts in which they no longer repel each other; and this would be the distance at which they would arrange themselves if they were not heavy. But at the very summit of the atmosphere they will be a very small matter nearer to each other, on account of their gravitation to the earth. Till we know precisely the law of this mutual repulsion, we cannot say what is the height of the atmosphere.

But if the air be an elastic fluid whose density is always

Height of the Atmosphere.

218

219

The height of the air investigated from its compressibility, &c.

220
Plate
CCCCIV.

221

Experiment fixes no limit to the air's expandibility.

Height of
the Atmos-
phere.

222
Further ob-
servations
on, and in-
vestigation
of, the
height of
the atmo-
sphere.

223

224

225
Plate
CCCCIV.

226

ways proportionable to the compressing force, we can tell what is its density at any height above the surface of the earth: and we can compare the density so calculated with the density discovered by observation: for this last is measured by the height at which it supports mercury in the barometer. This is the direct measure of the pressure of the external air; and as we know the law of gravitation, we can tell what would be the pressure of air having the calculated density in all its parts.

Let us therefore suppose a prismatic or cylindric column of air reaching to the top of the atmosphere. Let this be divided into an indefinite number of strata of very small and equal depths or thickness; and let us, for greater simplicity, suppose at first that a particle of air is of the same weight at all distances from the centre of the earth.

The absolute weight of any one of these strata will on these conditions be proportional to the number of particles or the gravity of air contained in it; and since the depth of each stratum is the same, this quantity of air will evidently be as the density of the stratum: but the density of any stratum is as the compressing force; that is, as the pressure of the strata above it; that is, as their weight; that is, as their quantity of matter—therefore the quantity of air in each stratum is proportional to the quantity of air above it; but the quantity in each stratum is the difference between the column incumbent on its bottom and on its top: these differences are therefore proportional to the quantities of which they are the differences. But when there is a series of quantities which are proportional to their own differences, both the quantities and their differences are in continual or geometrical progression: for let a, b, c , be three such quantities that

$$b : c = a - b : b - c, \text{ then, by altern.}$$

$$b : a - b = c : b - c \quad \text{and by compos.}$$

$$b : a = c : b$$

$$\text{and } a : b = b : c$$

therefore the densities of these strata decrease in a geometrical progression; that is, when the elevations above the centre or surface of the earth increase, or their depths under the top of the atmosphere decrease, in an arithmetical progression, the densities decrease in a geometrical progression.

Let ARQ (fig. 55.) represent the section of the earth by a plane through its centre O , and let $m OAM$ be a vertical line, and AE perpendicular to OA will be a horizontal line through A , a point on the earth's surface. Let AE be taken to represent the density of the air at A ; and let DH , parallel to AE , be taken to AE as the density at D is to the density at A : it is evident, that if a logistic or logarithmic curve EHN be drawn, having AN for its axis, and passing through the points E and H , the density of the air at any other point C , in this vertical line, will be represented by CG , the ordinate to the curve in that point: for it is the property of this curve, that if portions AB, AC, AD , of its axis be taken in arithmetical progression, the ordinates AE, BF, CG, DH , will be in geometrical progression.

It is another fundamental property of this curve, that if EK or HS touch the curve in E or H , the subtangent AK or DS is a constant quantity.

And a third fundamental property is, that the infinitely extended area $MAEN$ is equal to the rectangle $KAEL$ of the ordinate and subtangent; and, in like manner, the area $MDHN$ is equal to $SD \times DH$, or to $KA \times DH$; consequently the area lying beyond any ordinate is proportional to that ordinate.

These geometrical properties of this curve are all analogous to the chief circumstances in the constitution of the atmosphere, on the supposition of equal gravity. The area $MCGN$ represents the whole quantity of aerial matter which is above C ; for CG is the density at C , and CD is the thickness of the stratum between C and D ; and therefore $CGHD$ will be as the quantity of matter or air in it; and in like manner of all the others, and of their sums, or the whole area $MCGN$; and as each ordinate is proportional to the area above it, so each density, and the quantity of air in each stratum, is proportional to the quantity of air above it: and as the whole area $MAEN$ is equal to the rectangle $KAEL$, so the whole air of variable density above A might be contained in a column KA , if, instead of being compressed by its own weight, it were without weight, and compressed by an external force equal to the pressure of the air at the surface of the earth. In this case, it would be of the uniform density AE , which it has at the surface of the earth, making what we have repeatedly called the homogeneous atmosphere.

Hence we derive this important circumstance, that the height of the homogeneous atmosphere is the subtangent of that curve whose ordinates are as the densities of the air at different heights, on the supposition of equal gravity. This curve may with propriety be called the *ATMOSPHERICAL LOGARITHMIC*: and as the different logarithmics are all characterised by their subtangents, it is of importance to determine this one.

It may be done by comparing the densities of mercury and air. For a column of air of uniform density, reaching to the top of the homogeneous atmosphere, is in equilibrio with the mercury in the barometer. Now it is found, by the best experiments, that when mercury and air are of the temperature 32° of Fahrenheit's thermometer, and the barometer stands at 30 inches, the mercury is nearly 10440 times denser than air. Therefore the height of the homogeneous atmosphere is 10440 times 30 inches, or 26100 feet, or 8700 yards, or 4350 fathoms, or 5 miles wanting 100 yards.

Or it may be found by observations on the barometer. It is found, that when the mercury and air are of the above temperature, and the barometer on the sea-shore stands at 30 inches, if we carry it to a place 884 feet higher it will fall to 29 inches. Now, in all logarithmic curves having equal ordinates, the portions of the axes intercepted between the corresponding pairs of ordinates are proportional to the subtangents. And the subtangents of the curve belonging to our common tables is 0,4342945, and the difference of the logarithms of 30 and 29 (which is the portion of the axis intercepted between the ordinates 30 and 29), or 0,0147233, is to 0,4342945 as 883 is to 26058 feet, or 8686 yards, or 4343 fathoms, or 5 miles wanting 114 yards. This determination is 14 yards less than the other, and it is uncertain which is the most exact. It is extremely difficult to measure the respective densities of mercury and air; and in measuring the elevation which produces

He takes a fall of one inch in the barometer, an error of the 1st of an inch would produce all the difference. We prefer the last, as depending on fewer circumstances.

But all this investigation proceeds on the supposition of equal gravity, whereas we know that the weight of a particle of air decreases as the square of its distance from the centre of the earth increases. In order, therefore, that a superior stratum may produce an equal pressure at the surface of the earth, it must be denser, because a particle of it gravitates less. The density, therefore, at equal elevations, must be greater than on the supposition of equal gravity, and the law of diminution of density must be different.

Make $QD : OA = OA : O'.$

$$OC : OA = OA : O ;$$

$$OB : OA = OA : O^h, \&c;$$

fo that Od, Oc, Ob, OA , may be reciprocals to OD, OC, OB, OA ; and through the points A, b, c, d , draw the perpendiculars AE, bf, cg, dh , making them proportional to the densities in A, B, C, D : and let us fuppofe CD to be exceedingly fmall, fo that the density may be fuppofed uniform through the whole ftratum. Thus we have

$$OD \times Od = OA^2, = OC \times Oc$$

and $Oa : Od = OD : OC$;

and $O_c : O_c - O \neq OD : OD - OC,$

or $O_c : cd = OD : DC;$

and $cd : CD = Oc : OD$;

or, because OC and OD are ultimately in the ratio of equality, we have

$$cd : CD = Oc : OC = OA' : OC,$$

$$\text{and } cd = CD \times \frac{OA^2}{OC^2}, \text{ and } cd \times cg = CD \times cg \times \frac{OA^2}{OC^2};$$

but $CD \times c_d \times \frac{OA^3}{OC^3}$ is as the pressure at C arising from the absolute weight of the stratum CD. For this weight is as the bulk, as the density, and as the gravitation of each particle jointly. Now CD expresses

the bulk, cg the density, and $\frac{OA^2}{OC^2}$ the gravitation of each particle. Therefore, $cd \times cg$ is as the pressure on C arising from the weight of the stratum DC ; but $cd \times cg$ is evidently the element of the curvilinear area $A mnE$, formed by the curve $Efgbn$ and the ordinates $AE, bf, cg, ah, \&c. mn$. Therefore the sum of all the elements, such as $cdhg$, that is, the area $cmng$ below cg , will be as the whole pressure on C , arising from the gravitation of all the air above it; but, by the nature of air, this whole pressure is as the density which it produces, that is, as cg . Therefore the curve Egn is of such a nature that the area lying below or beyond any ordinate cg is proportional to that ordinate. This is the property of the logarithmic curve, and Egn is a logarithmic curve.

But farther, this curve is the same with EGN. For let B continually approach to A, and ultimately coincide with it. It is evident that the ultimate ratio of BA to Ab, and of BF to bf, is that of equality; and if EFK, Efk, be drawn, they will contain equal angles with the ordinate AE, and will cut off equal subtangents AK, Ak. The curves EGN, Egn are therefore the same, but in opposite positions.

Lastly, if $OA, Ob, Oc, Od, \&c.$ be taken in arithmetical progression decreasing, their reciprocals $OA, OB,$

VOL. XV. Part I.

OC, OD, &c. will be in harmonical progression increasing, as is well known: but, from the nature of the logarithmic curve, when OA, Ob, Oc, Od, &c. are in arithmetical progression, the ordinates AE, bf, cg, dh, &c. are in geometrical progression. Therefore when OA, OB, OC, OD, &c. are in harmonical progression, the densities of the air at A, B, C, D, &c. are in geometrical progression; and thus may the density of the air at all elevations be discovered. Thus to find the density of the air at K the top of the homogeneous atmosphere, make OK : OA :: OA : OL, and draw the ordinate LT, LT is the density at K.

The celebrated Dr Halley was the first who observed the relation between the density of the air and the ordinates of the logarithmic curve, or common logarithms. This he did on the supposition of equal gravity; and his discovery is acknowledged by Sir Isaac Newton in *Princip. ii. prop. 22. schol.* Halley's dissertation on the subject is in n^o 185 of the Phil. Transf. Newton, with his usual sagacity, extended the same relation to the true state of the case, where gravity is as the square of the distance inversely; and showed that when the distances from the earth's centre are in harmonic progression, the densities are in geometric progression. He shows indeed, in general, what progression of the distance, on any supposition of gravity, will produce a geometrical progression of the densities, so as to obtain a set of lines OA, Ob, Oc, Od, &c. which will be logarithms of the densities. The subject was afterwards treated in a more familiar manner by Cotes in his *Hydrost. Lect.* and in his *Harmonia Mensurarum*; also by Dr Brooke Taylor, *Metb. Increment*; Wolf in his *Acrometria*; Herman in his *Phoronomia*; &c. &c. and lately by Horsley, Phil. Transf. tom. lxiv.

An important corollary is deducible from these principles, viz. that the air has a finite density at an infinite distance from the centre of the earth, namely, such as will be represented by the ordinate OP drawn through the centre. It may be objected to this conclusion, that it would infer an infinity of matter in the universe, and that it is inconsistent with the phenomena of the planetary motions, which appear to be performed in a space void of all resistance, and therefore of all matter. But this fluid must be so rare at great distances, that the resistance will be insensible, even though the retardation occasioned by it has been accumulated for ages. Even at the very moderate distance of 500 miles, the rarity is so great that a cubic inch of common air expanded to that degree would occupy a sphere equal to the orbit of Saturn; and the whole retardation which this planet would sustain after some millions of years would not exceed what would be occasioned by its meeting one bit of matter of half a grain weight.

This being the case, it is not unreasonable to suppose the visible universe occupied by air, which, by its gravitation, will accumulate itself round every body in it, in a proportion depending on their quantities of matter, the larger bodies attracting more of it than the smaller ones, and thus forming an atmosphere about each. And many appearances warrant this supposition. Jupiter, Mars, Saturn, and Venus, are evidently surrounded by atmospheres. The constitution of these atmospheres may differ exceedingly from other causes. If the planet has nothing on its surface which can be dissolved

Height of
the Atmo-
sphere.

254
The air has
a finite
density at
an infinite
distance
from the
centre of
the earth.

Atmo-
spheres
of the other
Planets,
&c.

235
The atmo-
sphere of
Mars,

236
Of Jupiter,

237
Of Venus,

by the air or volatilised by heat, the atmosphere will be continually clear and transparent, like that of the moon.

Mars has an atmosphere which appears precisely like our own, carrying clouds, or depositing snows: for when, by the obliquity of his axis to the plane of his ecliptic, he turns his north pole towards the sun, it is observed to be occupied by a broad white spot. As the summer of that region advances, this spot gradually wastes, and sometimes vanishes, and then the south pole comes in sight, surrounded in like manner with a white spot, which undergoes similar changes. This is precisely the appearance which the snowy circumpolar regions of this earth will exhibit to an astronomer on Mars. It may not, however, be snow that we see; thick clouds will have the same appearances.

The atmosphere of the planet Jupiter is also very similar to our own. It is diversified by streaks or belts parallel to his equator, which frequently change their appearance and dimensions, in the same manner as those tracks of similar sky which belong to different regions of this globe. There is a certain kind of weather that more properly belongs to a particular climate than to any other. This is nothing but a certain general state of the atmosphere which is prevalent there, though with considerable variations. This must appear to a spectator in the moon like a streak spread over that climate, distinguishing it from others. But the most remarkable similarity is in the motion of the clouds on Jupiter. They have plainly a motion from east to west relative to the body of the planet: for there is a remarkable spot on the surface of the planet, which is observed to turn round the axis in 9h. 51' 16"; and there frequently appear variable and perishing spots in the belts, which sometimes last for several revolutions. These are observed to circulate in 9. 55. 05. These numbers are the results of a long series of observations by Dr Herschel. This plainly indicates a general current of the clouds westward, precisely similar to what a spectator in the moon must observe in our atmosphere arising from the trade-winds. Mr Schroeter has made the atmosphere of Jupiter a study for many years; and deduces from his observations that the motion of the variable spots is subject to great variations, but is always from east to west. This indicates variable winds.

The atmosphere of Venus appears also to be like ours, loaded with vapours, and in a state of continual change of absorption and precipitation. About the middle of last century the surface of Venus was pretty distinctly seen for many years chequered with irregular spots, which are described by Campani, Bianchini, and other astronomers in the south of Europe, and also by Cassini at Paris, and Hooke and Townley in England. But the spots became gradually more faint and indistinct; and, for near a century, have disappeared. The whole surface appears now of one uniform brilliant white. The atmosphere is probably filled with a reflecting vapour, thinly diffused through it, like water faintly tinged with milk. A great depth of this must appear as white as a small depth of milk itself; and it appears to be of a very great depth, and to be refractive like our air. For Dr Herschel has observed, by the help of his fine telescopes, that the illuminated part of Venus is considerably more than a hemisphere, and that the light dies gradually away to the bounding

margin. This is the very appearance that the earth would make if furnished with such an atmosphere. The boundary of illumination would have a penumbra reaching about nine degrees beyond it. If this be the constitution of the atmosphere of Venus, she may be inhabited by beings like ourselves. They would not be dazzled by the intolerable splendor of a sun four times as big and as bright, and sixteen times more glaring, than ours; for they would seldom or never see him, but instead of him an uniformly bright and white sky. They would probably never see a star or planet, unless the dog-star and Mercury; and perhaps the earth might pierce through the bright haze which surrounds their planet. For the same reason the inhabitants would not perhaps be incommoded by the sun's heat. It is indeed a very questionable thing, whether the sun would cause any heat, even here, if it were not for the chemical action of his rays on our air. This is rendered not improbable by the intense cold felt on the tops of the highest mountains, in the clearest air, and even under a vertical sun in the torrid zone.

The atmosphere of comets seems of a nature totally different. This seems to be of inconceivable rarity, even when it reflects a very sensible light. The tail is always turned nearly away from the sun. It is thought that this is by the impulse of the solar rays. If this be the case, we think it might be discovered by the aberration and the refraction of the light by which we see the tail: for this light must come to our eye with a much smaller velocity than the sun's light, if it be reflected by repulsive or elastic forces, which there is every reason in the world to believe; and therefore the velocity of the reflected light will be diminished by all the velocity communicated to the reflecting particles. This is almost inconceivably great. The comet of 1680 went half round the sun in ten hours, and had a tail at least a hundred millions of miles long, which turned round at the same time, keeping nearly in the direction opposite to the sun. The velocity necessary for this is prodigious, approaching to that of light. And perhaps the tail extends much farther than we see it, but is visible only as far as the velocity with which its particles recede from the sun is less than a certain quantity, namely, what would leave a sufficient velocity for the reflected light to enable it to affect our eyes. And it may be demonstrated, that although the real form of the visible tail is concave on the anterior side to which the comet is moving, it may appear convex on that side, in consequence of the very great aberration of the light by which the remote parts are seen. All this may be discovered by properly contrived observations; and the conjecture merits attention. But of this digression there is enough; and we return to our subject, the constitution of our air.

We have shown how to determine *à priori* the density of the air at different elevations above the surface of the earth. But the densities may be discovered in all accessible elevations by experiments; namely, by observing the heights of the mercury in the barometer. This is a direct measure of the pressure of the incumbent atmosphere; and this is proportional to the density which it produces.

Therefore, by means of the relation subsisting between the densities and the elevations, we can discover the elevations by observations made on the densities by means

Barometer of the barometer; and thus we may measure elevations by means of the barometer; and, with very little trouble, take the level of any extensive track of country. Of this we have an illustrious example in the section which the Abbé Chappé D'Auteroche has given of the whole country between Brest and Ekaterinenburgh in Siberia. This is a subject which deserves a minute consideration: we shall therefore present it under a very simple and familiar form; and trace the method through its various steps of improvement by De Luc, Roy, Shuckburgh, &c.

We have already observed oftener than once, that if the mercury in the barometer stands at 30 inches, and if the air and mercury be of the temperature 32° in Fahrenheit's thermometer, a column of air 87 feet thick has the same weight with a column of mercury $\frac{1}{10}$ of an inch thick. Therefore, if we carry the barometer to a higher place, so that the mercury sinks to 29.9, we have ascended 87 feet. Now, suppose we carry it still higher, and that the mercury stands at 29.8; it is required to know what height we have now got to? We have evidently ascended through another stratum of equal weight with the former: but it must be of greater thickness, because the air in it is rarer, being less compressed. We may call the density of the first stratum 300, measuring the density by the number of tenths of an inch of mercury which its elasticity proportional to its density enables it to support. For the same reason, the density of the second stratum must be 299: but when the weights are equal, the bulks are inversely as the densities; and when the bases of the strata are equal, the bulks are as the thicknesses. Therefore, to obtain the thickness of this second stratum, say 299:300=87:87.29; and this fourth term is the thickness of the second stratum, and we have ascended in all 174.29 feet. In like manner we may rise till the barometer shows the density to be 298: then say, 298:300=87:87.584 for the thickness of the third stratum, and 261.875 or 261 $\frac{1}{2}$ for the whole ascent; and we may proceed in the same way for any number of mercurial heights, and make a table of the corresponding elements as follows: where the first column is the height of the mercury in the barometer, the second column is the thickness of the stratum, or the elevation above the preceding station; and the third column is the whole elevation above the first station.

Bar.	Strat.	Elev.
30	00,000	00,000
29.9	87,000	87,000
29.8	87,291	174,291
29.7	87,584	261,875
29.6	87,879	349,754
29.5	88,176	437,930
29.4	88,475	526,405
29.3	88,776	615,181
29.2	89,079	704,260
29.1	89,384	793,644
29	89,691	883,335

Having done this, we can now measure any elevation within the limits of our table, in this manner.

Observe the barometer at the lower and at the upper stations, and write down the corresponding elevations. Subtract the one from the other, and the remainder is the height required. Thus suppose that at the lower

station the mercurial height was 29.8, and that at the upper station it was 29.1.

29.1 793,644
29.8 174,291

619,353 = Elevation.

We may do the same thing with tolerable accuracy without the table, by taking the medium m of the mercurial heights, and their difference d in tenths of an inch; and then say, as m to 300, so is $87d$ to the height required h : or $h = \frac{300 \times 87d}{m} = \frac{26100d}{m}$. Thus, in the foregoing example, m is 294.5, and d is 7; and therefore $h = \frac{7 \times 26100}{294.5} = 620.4$, differing only one foot from the former value.

Either of these methods is sufficiently accurate for most purposes, and even in very great elevations will not produce any error of consequence: the whole error of the elevation 883 feet 4 inches, which is the extent of the above table, is only $\frac{1}{2}$ of an inch.

But we need not confine ourselves to methods of approximation, when we have an accurate and scientific method that is equally easy. We have seen that, upon the supposition of equal gravity, the densities of the air are as the ordinates of a logarithmic curve, having the line of elevations for its axis. We have also seen that, in the true theory of gravity, if the distances from the centre of the earth increase in a harmonic progression, the logarithm of the densities will decrease in an arithmetical progression; but if the greatest elevation above the surface be but a few miles, this harmonic progression will hardly differ from an arithmetical one. Thus, if Ab, Ac, Ad , are 1, 2, and 3 miles, we shall find that the corresponding elevations AB, AC, AD are sensibly in arithmetical progression also: for the earth's radius AC is nearly 4000 miles. Hence it plainly follows,

that $BC - AB$ is $\frac{1}{4000 \times 4001}$, or $\frac{1}{16004000}$ of a mile, or $\frac{1}{250}$ of an inch; a quantity quite insignificant. We may therefore affirm without hesitation, that in all accessible places, the elevations increase in an arithmetical progression, while the densities decrease in a geometrical progression. Therefore the ordinates are proportional to the numbers which are taken to measure the densities, and the portions of the axis are proportional to the logarithms of these numbers. It follows, therefore, that we may take such a scale for measuring the densities, that the logarithms of the numbers of this scale shall be the very portions of the axis; that is, of the vertical line in feet, yards, fathoms, or what measure we please: and we may, on the other hand, choose such a scale for measuring our elevations, that the logarithms of our scale of densities shall be parts of this scale of elevations; and we may find either of these scales scientifically. For it is a known property of the logarithmic curves, that when the ordinates are the same, the intercepted portions of the abscissæ are proportional to their subtangents. Now we know the subtangent of the atmospherical logarithmic: it is the height of the homogeneous atmosphere in any measure we please, suppose fathoms: we find this height by comparing the gravities of air and mercury, when

Barometer. both are of some determined density. Thus, in the temperature of 32° of Fahrenheit's thermometer, when the barometer stands at 30 inches, it is known (by many experiments) that mercury is 10423,068 times heavier than air; therefore the height of the balancing column of homogeneous air will be 10423,068 times 30 inches; that is, 4342,945 English fathoms. Again, it is known that the subtangent of our common logarithmic tables, where 1 is the logarithm of the number 10, is 0,4342945. Therefore the number 0,4342945 is to the difference D of the logarithms of any two barometric heights as 4342,945 fathoms are to the fathoms F contained in the portion of the axis of the atmospherical logarithmic, which is intercepted between the ordinates equal to these barometrical heights; or that 0,4342945 : D :: 4342,945 : F, and 0,4342,945 : 4342,945 :: D : F; but 0,4342945 is the ten thousandth part of 4342,945, and therefore D is the ten-thousandth part of F.

244 And thus it happens, by mere chance, that the logarithms of the densities, measured by the inches of mercury which their elasticity supports in the barometer, are just the ten-thousandth part of the fathoms contained in the corresponding portions of the axis of the atmospherical logarithmic. Therefore, if we multiply our common logarithms by 10000, they will express the fathoms of the axis of the atmospherical logarithmic; nothing is more easily done. Our logarithms contain what is called the index or characteristic, which is an integer and a number of decimal places. Let us just remove the integer-place four figures to the right hand: thus the logarithm of 60 is 1.7781513, which is one integer and $\frac{7781513}{10000000}$. Multiply this by 10,000, and we ob-

tain $\frac{513}{1001}$ 17781,513, or 17781 $\frac{513}{1000}$.

245 The practical application of all this reasoning is obvious and easy: observe the heights of the mercury in the barometer at the upper and lower stations in inches and decimals; take the logarithms of these, and subtract the one from the other: the difference between them (accounting the four first decimal figures as integers) is the difference of elevation of fathoms.

Example.

Merc. Height at the lower station 29,8	1.4742163
upper station 29,1	1.4638930

Diff. of Log. $\times 10000$ 0.0103233

or 103 fathoms and $\frac{233}{1000}$ of a fathom, which is 619,392 feet, or 619 feet $4\frac{1}{2}$ inches; differing from the approximated value formerly found about $\frac{1}{4}$ an inch.

246 This method of measuring heights now much improved. Such is the general nature of the barometric measurement of heights first suggested by Dr Halley; and it has been verified by numberless comparisons of the heights calculated in this way with the same height measured geometrically. It was indeed in this way that the precise specific gravity of air and mercury was most accurately determined; namely, by observing, that when the temperature of air and mercury was 32, the difference of the logarithms of the mercurial heights were precisely the fathoms of elevation. But it requires many corrections to adjust this method to the circumstances of

the case; and it was not till very lately that it has been so far adjusted to them as to become useful. We are chiefly indebted to Mr de Luc for the improvements. The great elevations in Switzerland enabled him to make an immense number of observations, in almost every variety of circumstances. Sir George Shuckburgh also made a great number with most accurate instruments in much greater elevations, in the same country; and he made many chamber experiments for determining the laws of variation in the subordinate circumstances. General Roy also made many to the same purpose. And to these two gentlemen we are chiefly obliged for the corrections which are now generally adopted.

It is easy to perceive that the method, as already expressed, cannot apply to every case: it depends on the specific gravity of air and mercury, combined with the supposition that this is affected *only by a change of pressure*. But since all bodies are expanded by heat, and as there is no reason to suppose that they are equally expanded by it, it follows that a change of temperature will change the relative gravity of mercury and air, even although both suffer the same change of temperature: and since the air may be warmed or cooled when the mercury is not, or may change its temperature independent of it, we may expect still greater variations of specific gravity.

The general effect of an augmentation of the specific gravity of the mercury must be to increase the subtangent of the atmospherical logarithmic; in which case the logarithms of the densities, as measured by inches of mercury, will express measures that are greater than fathoms in the same proportion that the subtangent is increased; or, when the air is more expanded than the mercury, it will require a greater height of homogeneous atmosphere to balance 30 inches of mercury, and a given fall of mercury will then correspond to a thicker stratum of air.

In order, therefore, to perfect this method, we must learn by experiment how much mercury expands by an increase of temperature; we must also learn how much the air expands by the same, or any change of temperature; and how much its elasticity is affected by it. Both these circumstances must be considered in the case of air; for it might happen that the elasticity of the air is not so much affected by heat as its bulk is.

It will, therefore, be proper to state in this place the experiments which have been made for ascertaining these two expansions.

The most accurate, and the best adapted experiments for ascertaining the expansion of mercury, are those of General Roy, published in the 67th volume of the Philosophical Transactions. He exposed 30 inches of mercury, actually supported by the atmosphere in a barometer, in a nice apparatus, by which it could be made of one uniform temperature through its whole length; and he noted the expansion of it in decimals of an inch. These are contained in the following table; where the first column expresses the temperature by Fahrenheit's thermometer, the second column expresses the bulk of the mercury, and the third column the expansion of an inch of mercury for an increase of one degree in the adjoining temperatures.

TABLE

TABLE A.

Temp.	Bulk of $\frac{1}{2}$.	Expan. for 1°
212°	30,5117	0,0000763
202	30,4888	0,0000787
192	30,4652	0,0000810
182	30,4409	0,0000833
172	30,4159	0,0000857
162	30,3902	0,0000880
152	30,3638	0,0000903
142	30,3367	0,0000923
132	30,3090	0,0000943
122	30,2807	0,0000963
112	30,2518	0,0000983
102	30,2223	0,0001003
92	30,1922	0,0001023
82	30,1615	0,0001043
72	30,1302	0,0001063
62	30,0984	0,0001077
52	30,0661	0,0001093
42	30,0333	0,0001110
32	30,0000	0,0001127
22	29,9662	0,0001143
12	29,9319	0,0001160
2	29,8971	0,0001177
0	29,8901	

the true measure of the density of the air of the standard temperature. In order that we may obtain the exact temperature of the mercury, it is proper that the observation be made by means of a thermometer attached to the barometer-frame, so as to warm and cool along with it.

Taking heights.

Or, this may be done without the help of a table, and with sufficient accuracy, from the circumstance that the expansion of an inch of mercury for one degree diminishes very nearly $\frac{1}{50}$ th part in each succeeding degree. If therefore we take from the expansion at 32° its thousandth part for each degree of any range above it, we obtain a mean rate of expansion for that range. If the observed temperature of the mercury is below 32° , we must *add* this correction to obtain the mean expansion. This rule will be made more exact if we suppose the expansion at 32° to be $=0,0001127$. Then multiply the observed mercurial height by this expansion, and we obtain the correction, to be subtracted or added according as the temperature of the mercury was above or below 32° . Thus to abide by the former example of 72° . This exceeds 32° by 40: therefore take 40 from 0,0001127, and we have 0,0001087 for the medium expansion for that range. Multiply this by 40, and we have the whole expansion of one inch of mercury, $=0,004348$. Multiply the inches of mercurial height, viz. 29,2, by this expansion, and we have for the correction 0,12696; which being subtracted from the observed height leaves 29,07304, differing from the accurate quantity less than the thousandth part of an inch. This rule is very easily kept in the memory, and supercedes the use of a table.

This correction may be made with all necessary exactness by a rule still more simple; namely, by multiplying the observed height of the mercury by the difference of its temperature from 32° , and cutting off four cyphers before the decimals of the mercurial height. This will seldom err $\frac{1}{1000}$ of an inch. We even believe that it is the most exact method within the range of temperatures that can be expected to occur in measuring heights: for it appears, by comparing many experiments and observations, that General Roy's measure of the mercurial expansion is too great, and that the expansion of an inch of mercury between 20° and 70° of Fahrenheit's thermometer does not exceed 0,000102 *per* degree. Having thus corrected the observed mercurial heights by reducing them to what they would have been if the mercury had been of the standard temperature, the logarithms of the corrected heights are taken, and their difference, multiplied by 10000, will give the difference of elevations in English fathoms.

There is another way of applying this correction, fully more expeditious and equally accurate. The difference of the logarithms of the mercurial heights is the measure of the ratio of those heights. In like manner the difference of the logarithms of the observed and corrected heights at any station is the measure of the ratio of those heights. Therefore this last difference of the logarithms is the measure of the correction of this ratio. Now the observed height is to the corrected height nearly as 1 to 1,000102. The logarithm of this ratio, or the difference of the logarithms of 1 and 1,000102, is 0,0000444. This is the correction for each degree that the temperature of the mercury differs from 32° . Therefore multiply 0,0000444 by the difference of the mercurial temperatures from 32, and the products.

This table gives rise to some reflections. The scale of the thermometer is constructed on the supposition that the successive degrees of heat are measured by equal increments of bulk in the mercury of the thermometer. How comes it, therefore, that this is not accompanied by equal increments of bulk in the mercury of the column, but that the corresponding expansions of this column do continually diminish? General Roy attributes this to the gradual detachment of elastic matter from the mercury by heat, which presses on the top of the column, and therefore shortens it. He applied a boiling heat to the vacuum at-top, without producing any farther depression; a proof that the barometer had been carefully filled. It had indeed been boiled through its whole length. He had attempted to measure the mercurial expansion in the usual way, by filling 30 inches of the tube with boiled mercury, and exposing it to the heat with the open end uppermost. But here it is evident that the expansion of the tube, and its solid contents, must be taken into the account. The expansion of the tube was found so exceedingly irregular, and so incapable of being determined with precision for the tubes which were to be employed, that he was obliged to have recourse to the method with the real barometer. In this no regard was necessary to any circumstance but the perpendicular height. There was, besides, a propriety in examining the mercury in the very condition in which it was used for measuring the pressure of the atmosphere; because whatever complication there was in the results, it was the same in the barometer in actual use.

The most obvious manner of applying these experiments on the expansion of mercury to our purpose, is to reduce the observed height of the mercury to what it would have been if it were of the temperature 32° . Thus, suppose that the observed mercurial height is 29,2, and that the temperature of the mercury is 72° make $30,1302 : 30 = 29,2 : 29,0738$. This will be

Barometer. products will be the corrections of the respective logarithms.

234

But there is still an easier way of applying the logarithmic correction. If both the mercurial temperatures are the same, the differences of their logarithms will be the same, although each may be a good deal above or below the standard temperature, if the expansion be very nearly equable. The correction will be necessary only when the temperatures at the two stations are different, and will be proportional to this difference. Therefore, if the difference of the mercurial temperatures be multiplied by 0,0000444, the product will be the correction to be made on the difference of the logarithms of the mercurial heights.

But farther, since the differences of the logarithms of the mercurial heights are also the differences of elevation in English fathoms, it follows that the correction is also a difference of elevation in English fathoms, or that the correction for one degree of difference of mercurial temperature is $\frac{444}{1000}$ of a fathom, or 32 inches, or 2 feet 8 inches.

This correction of 2.8 for every degree of difference of temperature must be subtracted from the elevation found by the general rule, when the mercury at the upper station is colder than that at the lower. For when this is the case, the mercurial column at the upper station will appear too short, the pressure of the atmosphere too small, and therefore the elevation in the atmosphere will appear greater than it really is.

235

Therefore the rule for this correction will be to multiply 0,0000444 by the degrees of difference between the mercurial temperatures at the two stations, and to add or subtract the product from the elevation found by the general rule, according as the mercury at the upper station is hotter or colder than that at the lower.

236

If the experiments of General Roy on the expansion of the mercury in a real barometer be thought most deserving of attention, and the expansion be considered as variable, the logarithmic difference corresponding to this expansion for the mean temperature of the two barometers may be taken. These logarithmic differences are contained in the following table, which is carried as far as 112°, beyond which it is not probable that any observations will be made. The number for each temperature is the difference between the logarithms of 30 inches, of the temperature 32, and of 30 inches expanded by that temperature.

TABLE B.

Temp.	Log. diff.	Dec. of Fath.	Ft. In.
112°	0.0000427	,427	2.7
102	0.0000436	,436	2.7
92	0.0000444	,444	2.8
82	0.0000453	,453	2.9
72	0.0000460	,460	2.9
62	0.0000468	,468	2.10
52	0.0000475	,475	2.10
42	0.0000482	,482	2.11
32	0.0000489	,489	2.11
22	0.0000497	,497	3.0
12	0.0000504	,504	3.0
0			

237

The temperature of the air must also be attended to. It is also necessary to attend to the temperature of the air; and the change that is produced by heat in its density is of much greater consequence than that of the

mercury. The relative gravity of the two, on which the subtangent of the logarithmic curve depends, and consequently the unit of our scale of elevations, is much more affected by the heat of the air than by the heat of the mercury.

Taking heights.

This adjustment is of incomparably greater difficulty than the former, and we can hardly hope to make it perfect. We shall narrate the chief experiments which have been made on the expansion of air, and deduce from them such rules as appear to be necessary consequences of them, and then notice the circumstances which leave the matter still imperfect.

238

General Roy compared a mercurial and an air thermometer, each of which was graduated arithmetically, that is, the units of the scales were equal bulks of mercury, and equal bulks (perhaps different from the former) of air. He found their progress as in the following table.

TABLE C.

Merc.	Diff.	Air.	Diff.
212	20	212,0	17,6
192	20	194,4	18,2
172	20	176,2	18,8
152	20	157,4	19,4
132	20	138,0	20,0
112	20	118,0	20,8
92	20	97,2	21,6
72	20	75,6	22,6
52	20	53,0	21,6
32	20	31,4	20,0
12	20	11,4	

It has been established by many experiments that equal increments of heat produce equal increments in the bulk of mercury. The differences of temperature are therefore expressed by the second column, and may be considered as equal; and the numbers of the third column must be allowed to express the same temperatures with those of the first. They directly express the bulks of the air, and the numbers of the fourth column express the differences of these bulks. These are evidently unequal, and show that common air expands most of all when of the temperature 62 nearly.

The next point was to determine what was the actual increase of bulk by some known increase of heat. For this purpose he took a tube, having a narrow bore, and a ball at one end. He measured with great care the capacity of both the ball and the tube, and divided the tube into equal spaces which bore a determined proportion to the capacity of the ball. This apparatus was set in a long cylinder filled with frigorific mixtures or with water, which could be uniformly heated up to the boiling temperature, and was accompanied by a nice thermometer. The expansion of the air was measured by means of a column of mercury which rose or sunk in the tube. The tube being of a small bore, the mercury did not drop out of it; and the bore being chosen as equable as possible, this column remained of an uniform length, whatever part of the tube it chanced to occupy. By this contrivance he was able to examine the expansibility of air of various densities. When the column of mercury contained only a single drop or two, the air was nearly of the density of the external air. If he wished to examine the expansion of air twice or thrice as dense, he used a column of 30 or 60 inches long; and to examine the expansion of air that is rarer than

Taking
heights.

Baron or. the external air, he placed the tube with the ball uppermost, the open end coming through a hole in the bottom of the vessel containing the mixtures or water. By this position the column of mercury was hanging in the tube, supported by the pressure of the atmosphere; and the elasticity of the included air was measured by the difference between the suspended column and the common barometer.

The following table contains the expansion of 1000 parts of air, nearly of the common density, by heating it from 0 to 212. The first column contains the height of the barometer; the second contains this height augmented by the small column of mercury in the tube of the manometer, and therefore expresses the density of the air examined; the third contains the total expansion of 1000 parts; and the fourth contains the expansion for 1°, supposing it uniform throughout.

TABLE D.

Barom.	Density of Air examined.	Expansion of 1000 pts by 212°.	Expansion by 1°.
29,95	31,52	483,89	2,2825
30,07	30,77	482,10	2,2741
29,48	29,90	480,74	2,2676
29,90	30,73	485,86	2,2918
29,96	30,92	489,45	2,3087
29,90	30,55	476,04	2,2455
29,95	30,60	487,55	2,2998
30,07	30,60	482,80	2,2774
29,48	30,00	489,47	2,3087
Mean	30,62	484,21	2,2840

Hence it appears, that the mean expansion of 1000 parts of air of the density 30,62 by one degree of Fahrenheit's thermometer is 2,284, or that 1000 becomes 1002,284.

If this expansion be supposed to follow the same rate that was observed in the comparison of the mercurial and air thermometer, we shall find that the expansion of a thousand parts of air for one degree of heat at the different intermediate temperatures will be as in the following table.

TABLE E.

Temp.	Total Expansion	Expansion for 1°.
212	484,210	2,0099
192	444,011	2,0080
172	402,452	2,1475
152	359,503	2,2155
132	315,193	2,2840
112	269,513	2,3754
92	222,006	2,4211
82	197,795	2,5124
72	172,671	2,5581
62	147,090	2,6037
52	121,053	2,6524
42	95,929	2,7011
32	71,718	2,7497
22	48,421	2,7983
12	26,038	2,8468
0		

If we would have a mean expansion for any particular range, as between 12° and 92°, which is the most likely to comprehend all the geodetical observations, we need only take the difference of the bulks 26,038 and 222,006 = 195,968, and divide this by the interval of temperature 80°, and we obtain 2,4496, or 2,45 for the mean expansion for 1°.

It would perhaps be better to adapt the table to a mass of 1000 parts of air of the standard temperature 32°; for in its present form it shows the expansibility of air originally of the temperature 0. This will be done with sufficient accuracy by saying (for 212°) 1071,718 : 1484,210 = 1000 : 13849, and so of the rest. Thus we shall construct the following table of the expansion of 10,000 parts of air.

TABLE F.

Temp.	Bulk.	Differ.	Expans. for 1°.
212	13489		
192	13474	375	18,7
172	13087	387	19,3
152	12685	392	19,6
132	12272	413	20,6
112	11846	426	21,3
92	11403	443	22,1
82	11177	226	22,6
72	10942	235	23,5
62	10704	238	23,8
52	10461	243	24,3
42	10226	235	23,5
32	10000	226	22,6
22	9783	217	21,7
12	9574	209	20,9
0	9331	243	20,2

This will give for the mean expansion of 1000 parts of air between 12° and 92 = 2,29.

Although it cannot happen that in measuring the differences of elevation near the earth's surface, we shall have occasion to employ air greatly exceeding the common density, we may infer the experiments made by General Roy on such airs. They are expressed in the common following table; where column first contains the densities measured by the inches of mercury that they will support when of the temperature 32°; column second is the expansion of 1000 parts of such air by being heated from 0 to 212; and column third is the mean expansion for 1°.

TABLE G.

Density.	Expansion for 212.	Expans. of 1°
101,7	451,54	2,130
92,3	423,23	1,996
80,5	412,09	1,944
54,5	439,87	2,075
49,7	443,24	2,091
75,7	434	2,047

We have much more frequent occasion to operate in air that is rarer than the ordinary state of the superficial atmosphere. And on air below that density,

Barometer

atmosphere. General Roy accordingly made many experiments on such airs. He found in general, that their expansibility by heat was analogous to that of air in its ordinary density, being greatest about the temperature 60°. He found, too, that its expansibility by heat diminished with its density, but he could not determine the law of gradation. When reduced to about $\frac{1}{4}$ of the density of common air, its expansion was as follows.

TABLE H.

Temp.	Bulk.	Difference.	Expans. for 1°.
212	1141,504		
192	1134,429	7,075	0,354
172	1122,165	12,264	0,613
152	1108,015	14,150	0,708
132	1093,864	14,151	0,708
112	1079,636	14,228	0,711
92	1064,699	14,937	0,747
72	1043,788	20,911	1,045
52	1017,845	25,943	1,297
32	1000,000	17,845	0,892
Mean expansion			0,786

266
Air of ordinary density expands most, &c.

From this very extensive and judicious range of experiments, it is evident that the expansibility of air by heat is greatest when the air is about its ordinary density, and that in small densities it is greatly diminished. It appears also, that the law of compression is altered; for in this specimen of the rare air half of the whole expansion happens about the temperature 99°, but in air of ordinary density at 105°. This being the case, we see that the experiments of Mr Amontons, narrated in the Memoirs of the Academy at Paris 1702, &c. are not inconsistent with those more perspicuous experiments of General Roy. Amontons found, that whatever was the density of the air, at least in cases much denser than ordinary air, the change of 180° of temperature increased its elasticity in the same proportion: for he found, that the column of mercury which it supported when of the temperature 50, was increased $\frac{1}{4}$ at the temperature 212. Hence he hastily concluded, that its expansibility was increased in the same proportion; but this by no means follows, unless we are certain that in every temperature the elasticity is proportional to the density. This is a point which still remains undecided; and it merits attention, because if true it establishes a remarkable law concerning the action of heat, which would seem to go to prove that the elasticity of fluids is the property of the matter of fire, which it superinduces on every body with which it combines in the form of vapour.

267
The height which produces a given fall in the barometer, increases with the air's expansion.

After this account of the expansion of air, we see that the height through which we must rise in order to produce a given fall of the mercury in the barometer, or the thickness of the stratum of air equiponderant with a tenth of an inch of mercury, must increase with the expansion of air; and that if $\frac{2,29}{1000}$ be the expansion for one degree, we must multiply the excess of the temperature of the air above 32° by 0,00229, and multiply the product by 87, in order to obtain the thickness of the

stratum where the barometer stands at 30 inches; or whatever be the elevation indicated by the difference of the barometrical heights, upon the supposition that the air is of the temperature 32°, we must multiply this by 0,00229 for every degree that the air is warmer or colder than 32. The product must be added to the elevation in the first case, and subtracted in the latter.

Sir George Shuckbrough deduces 0,0024 from his experiments as the mean expansion of air in the ordinary cases: and this is probably nearer the truth; because General Roy's experiments were made on air which was freer from damp than the ordinary air in the fields; and it appears from his experiments, that a very minute quantity of damp increases its expansibility by heat in a prodigious degree.

The great difficulty is how to apply this correction; or rather, how to determine the temperature of the air in those extensive and deep strata in which the elevations are measured. It seldom or never happens that the stratum is of the same temperature throughout. It is commonly much colder aloft; it is also of different constitutions. Below it is warm, loaded with vapour, and very expansible; above it is cold, much drier, and less expansible, both by its dryness and its rarity. The currents of wind are often disposed in strata, which long retain their places; and as they come from different regions, are of different temperatures and different constitutions. We cannot therefore determine the expansion of the whole stratum with precision, and must content ourselves with an approximation: and the best approximation that we can make is, by supposing the whole stratum of a mean temperature between those of its upper and lower extremity, and employ the expansion corresponding to that mean temperature.

This, however, is founded on a gratuitous supposition, that the whole intermediate stratum expands alike, and that the expansion is equable in the different intermediate temperatures; but neither of these are warranted by experiment. Rare air expands less than what is denser; and therefore the general expansion of the whole stratum renders its density more uniform. Dr Horsley has pointed out some curious consequences of this in Phil. Trans. Vol. LXIV. There is a particular elevation at which the general expansion, instead of diminishing the density of the air, increases it by the superior expansion of what is below; and we know that the expansion is not equable in the intermediate temperatures: but we cannot find out a rule which will give us a more accurate correction than by taking the expansion for the mean temperature.

When we have done this, we have carried the method of measuring heights by the barometer as far as it can go; and this source of remaining error makes it needless to attend to some other very minute equations which theory points out. Such is the diminution of the weight of the mercury by the change of distance from the centre of the earth. This accompanies the diminution of the weight of the air, but neither so as to compensate it, nor to go along with it *pari passu*.

After all, there are found cases where there is a regular deviation from those rules, of which we cannot give any very satisfactory account. Thus it is found, that in the province of Quito in Peru, which is at a great elevation above the surface of the ocean, the heights obtained by these rules fall considerably short of the

Taking height.

268

269

Difficulties in this mode of measuring heights.

Barom. ^{er.} the real heights; and at Spitsbergen they considerably exceed them. It appears that the air in the circumpolar regions is denser than the air of the temperate climates when of the same heat and under the same pressure; and the contrary seems to be the case with the air in the torrid zone. It would seem that the specific gravity of air to mercury is at Spitsbergen about 1 to 10224, and in Peru about 1 to 13100. This difference is with great probability ascribed to the greater dryness of the circumpolar air.

This source of error will always remain; and it is combined with another, which should be attended to by all who practise this method of measuring heights, namely, a difference in the specific gravity of the quicksilver. It is thought sufficiently pure for a barometer when it is cleared of all calcinable matter, so as not to drag or fully the tube. In this state it may contain a considerable portion of other metals, particularly of silver, bismuth, and tin, which will diminish its specific gravity. It has been obtained by revivification from cinnabar of the specific gravity 14,229, and it is thought very fine if 13,65. Sir George Shuckburgh found the quicksilver which agreed precisely with the atmospheric observations on which the rules are founded to have the specific gravity 13,61. It is seldom obtained so heavy. It is evident that these variations will change the whole results; and that it is absolutely necessary, in order to obtain precision, that we know the density of the mercury employed. The subtangent of the atmospheric logarithmic, or the height of the homogeneous atmosphere, will increase in the same proportion with the density of the mercury; and the elevation corresponding to $\frac{1}{10}$ of an inch of barometric height will change in the same proportion.

We must be contented with the remaining imperfections: and we can readily see, that, for any purpose that can be answered by such measurements of great heights, the method is sufficiently exact; but it is quite inadequate to the purpose of taking accurate levels, for directing the construction of canals, aqueducts, and other works of this kind, where extreme precision is absolutely necessary.

We shall now deduce from all that has been said on this subject sets of easy rules for the practice of this mode of measurement, illustrating them by an example.

1. *M. DE LUC's Method.*

I. Subtract the logarithm of the barometrical height at the upper station from the logarithm of that at the lower, and count the index and four first decimal figures of the remainder as fathoms, the rest as a decimal fraction. Call this the *elevation*.

II. Note the different temperatures of the mercury at the two stations, and the mean temperature. Multiply the logarithmic expansion corresponding to this mean temperature (in Table B, p. 126.) by the difference of the two temperatures, and subtract the product from the elevation if the barometer has been coldest at the upper station, otherwise add it. Call the difference or the sum the *approximated elevation*.

III. Note the difference of the temperatures of the air at the two stations by a detached thermometer, and also the mean temperature and its difference from 32°. Multiply this difference by the expansion of air for the mean temperature, and multiply the approximate elevation

by $1 \pm$ this product, according as the air is above or below 32°. The product is the correct elevation in fathoms and decimals.

Example.

Suppose that the mercury in the barometer at the lower station was at 29,4 inches, that its temperature was 50°, and the temperature of the air was 45; and let the height of the mercury at the upper station be 25,19 inches, its temperature 46°, and the temperature of the air 39°. Thus we have

Bar. Hts.	Temp. Hg.	Mean.	Temp. Air.	Mean.
29,4	50		45	
25,19	46	48	39	42
I. Log. of 29,4				
		-		1.4683473
Log. of 25,19				
		-		1.4012282
Elevation in fathoms				671,191
II. Expans. for 48°				
		473		
Multiply by				4
				1,892
Approximated elevation				669,299
III. Expans. of air at 42				
		0,00238		
$\times 42 - 32 = 10$				10
				0,0238
Multiply				669,2990
By				1,0238
Product = the correct elevation				685,228

2. *Sir GEORGE SHUCKBOURGH's Method.*

I. Reduce the barometrical heights to what they would be if they were of the temperature 32°. 271
And according to Shuckburgh.

II. The difference of the logarithms of the reduced barometrical heights will give the approximate elevation.

III. Correct the approximated elevation as before.

Same Example.

I. Mean expans. for 1° from Tab. A, p. 125. is 0,000111.

18° \times 0,000111 \times 29,4 = 0,059
Subtract this from 29,4

Reduced barometrical height 29,341

Expans. from Tab. A, p. 125. is 0,000111.
14° \times 0,000111 \times 25,19 = 0,039
Subtract from 25,190

Reduced barometrical height 25,151

II. Log. 29,341 1.4674749
Log. 25,151 1.4005553

Approximated elevation 669,196

III. This multiplied by 1,0238 gives 685,125

Remark 1. If 0,000101 be supposed the mean expansion of mercury for 1°, as Sir George Shuckburgh determines it, the reduction of the barometrical heights will be had sufficiently exact by multiplying the observed

R ved

Barometer

ved heights of the mercury by the difference of its temperatures from 32, and cutting off four more decimal places; thus $29,4 \frac{\times 18}{10000}$ gives for the reduced height

29,347, and $25,19 \times \frac{14}{10000}$ gives 25,155, and the difference of their logarithms gives 669,4 fathoms for the approximated elevation, which differs from the one given above by no more than 15 inches.

273

Remark 2. If 0,0024 be taken for the expansion of air for one degree, the correction for this expansion will be had by multiplying the approximated elevation by 12, and this product by the sum of the differences of the temperatures from 32°, counting that difference as negative when the temperature is below 32, and cutting off four places; thus $669,196 \times 12 \times 13 + 07 \times \frac{1}{10000} = 16,061$, which added to 669,196 gives 685,257, differing from the former only 9 inches.

274
An easy
rule with-
out the
help of
tables.

From the same premises we may derive a rule, which is abundantly exact for all geodetical purposes, and which requires no tables of any kind, and is easily remembered.

1. The height through which we must rise in order to produce any fall of the mercury in the barometer, is inversely proportional to the density of the air, that is, to the height of the mercury in the barometer.

2. When the barometer stands at 30 inches, and the air and quicksilver are of the temperature 32, we must rise through 87 feet, in order to produce a depression of $\frac{1}{10}$ of an inch.

3. But if the air be of a different temperature, this 87 feet must be increased or diminished by 0,21 of a foot for every degree of difference of the temperature from 32°.

4. Every degree of difference of the temperatures of the mercury at the two stations makes a change of 2,833 feet, or 2 feet 10 inches in the elevation.

Hence the following rule.

275

1. Take the difference of the barometric heights in tenths of an inch. Call this d .

2. Multiply the difference a between 32, and the mean temperature of the air by 21, and take the sum or difference of this product and 87 feet. This is the height through which we must rise to cause the barometer to fall from 30 inches to 29,9. Call this height h .

Let m be the mean between the two barometric heights. Then $\frac{30 d h}{m}$ is the approximated elevation very nearly.

Multiply the difference δ of the mercurial temperatures by 2,83 feet, and add this product to the approximated elevation if the upper barometer has been the warmest, otherwise subtract it. The result, that is, the sum or difference, will be the corrected elevation.

Same Example.

$$d = 294 - 251,9 = 42,1$$

$$h = 87 + 10 \times 0,21 = 89,1$$

$$m = \frac{29,4 + 25,19}{2} = 27,29$$

$$\text{Approx. elevation} = \frac{30 \times 42,1 \times 89,1}{27,29} = 4123,24 \text{ feet.}$$

$$\text{Corr. for temp. of mercury} = 4 \times 2,83 = 11,32$$

$$\text{Corrected elevation in feet} = 4111,92$$

$$\text{Ditto in fathoms} = 685,32$$

Differing from the former only 15 inches.

This rule may be expressed by the following simple and easily remembered formula, where a is the difference between 32° and the mean temperature of the air, d is the difference of barometric heights in tenths of an inch, m is the mean barometric height, δ the difference between the mercurial temperatures, and E is the correct elevation. $E = \frac{30(87 \pm 0,21a)d}{m} \pm \delta \times 2,83$.

We shall now conclude this subject by an account of some of the most remarkable mountains, &c. on the earth, above the surface of the ocean, in feet.

Mount Puy de Domme in Auvergne, the first mountain measured by the barometer	5088
Mount Blanc	15662
Monte Rosa	15084
Aiguille d'Argenture	13402
Monastery of St Bernard	7944
Mount Cenis	9212
Pic de los Reyes	7620
Pic du Medi	9300
Pic d'Offiano	11700
Canegou	8544
Lake of Geneva	1232
Mount Aetna	10954
Mount Vesuvius	3938
Mount Hekla in Iceland	4887
Snowdown	3555
Ben Moir	3723
Ben Laurs	3858
Ben Gloe	3472
Shihallion	3461
Ben Lomond	3180
Tinto	2342
Table Hill, Cape of Good Hope	3454
Gondar city in Abyssinia	8440
Source of the Nile	8082
Pic of Teneriffe	14026
Chimboracon	19595
Cayambourow	19391
Antifana	19290
Pichinha (see PERU, n° 56.)	15670
City of Quito (see ditto)	9977
Caspian Sea below the ocean	306

This last is so singular, that it is necessary to give the authority on which this determination is founded. It is deduced from nine years observations with the barometer at Astrachan by Mr Lecre, compared with a series of observations made with the same barometer at St Petersburg.

This employment of the barometer has caused it to become a very interesting instrument to the philosopher and to the traveller; and many attempts have been made of late to improve it, and render it more portable. The improvements have either been directed to the enlargement

Measuring Heights

276

277
Heights of
the most
remarkable
mountains

278

Improved
barometer,
with a de-
scription of
Hooke's

Barometer. largement of its range, or to the more accurate measurement of its present scale. Of the first kind are Hooke's wheel barometer, the diagonal barometer, and the horizontal barometer, described in a former volume of this work. See BAROMETER. In that place are also described two very ingenious contrivances of Mr Rownings, which are evidently not portable. Of all the barometers with an enlarged scale the best is that invented by Dr Hooke in 1668, and described in the Phil. Trans. N^o 185. The invention was also claimed by Huyghens and by De la Hire; but Hooke's was published long before.

It consists of a compound tube ABCDEFG (fig. 56.), of which the parts AB and DE are equally wide, and EFG as much narrower as we would amplify the scale. The parts AB and EG must also be as perfectly cylindrical as possible. The part HBCDI is filled with mercury, having a vacuum above in AB. IF is filled with a light fluid, and FG with another light fluid which will not mix with that in IF. The cistern G is of the same diameter as AB. It is easy to see that the range of the separating surface at F must be as much greater than that of the surface I as the area of I is greater than that of F. And this ratio is in our choice. This barometer is free from all the bad qualities of those formerly described, being most delicately moveable; and is by far the fittest for a chamber, for amusement, by observations on the changes of the atmospheric pressure. The slightest breeze causes it to rise and fall, and it is continually in motion.

But this, and all other contrivances of the kind, are inferior to the common barometer for measurement of heights, on account of their bulk and cumbersome-ness: nay, they are inferior for all philosophical purposes in point of accuracy; and this for a reason that admits of no reply. Their scale must be determined in all its parts by the common barometer; and therefore, notwithstanding their great range, they are susceptible of no greater accuracy than that with which the scale of a common barometer can be observed and measured. This will be evident to any person who will take the trouble of considering how the points of their scale must be ascertained. The most accurate method for graduating such a barometer as we have now described would be to make a mixture of vitriolic acid and water, which should have $\frac{1}{10}$ of the density of mercury. Then, let a long tube stand vertical in this fluid, and connect its upper end with the open end of the barometer by a pipe which has a branch to which we can apply the mouth. Then if we suck through this pipe, the fluid will rise both in the barometer and in the other tube; and 10 inches rise in this tube will correspond to one inch descent in the common barometer. In this manner may every point of the scale be adjusted in due proportion to the rest. But it still remains to determine what particular point of the scale corresponds to some determined inch of the common barometer. This can only be done by an actual comparison; and this being done, the whole becomes equally accurate. Except therefore for the mere purpose of chamber amusement, in which case the barometer last described has a decided preference, the common barometer is to be preferred; and our attention should be entirely directed to its improvement and portability.

For this purpose it should be furnished with two microscopes or magnifying glasses, one of them stationed

at the beginning of the scale; which should either be moveable, so that it may always be brought to the surface of the mercury in the cistern, or the cistern should be so contrived that its surface may always be brought to the beginning of the scale. The glass will enable us to see the coincidence with accuracy. The other microscope must be moveable, so as to be set opposite to the surface of the mercury in the tube; and the scale should be furnished with a vernier which divides an inch into 1000 parts, and be made of materials of which we know the expansion with great precision.

For an account of many ingenious contrivances to the make instrument accurate, portable, and commodious, consult Magellan, *Differ. de diverses Instr. de Phys.*; *Phil. Trans.* lxvii. lxviii.; *Journ. de Phys.* xix. 108. 346. xvi. 392. xviii. 391. xxi. 436. xxii. 390.; Sulzer, *Art. Helvet.* iii. 259.; De Luc, *Recherches sur les Modifications de l'Atmosphere*, i. 401. ii. 459, 490. De Luc's seems the most simple and perfect of them all. Cardinal de Luynes (*Mem. Par.* 1768); Prin. De Luc, *Recherches*, § 63.; Van Swinden's *Positiones Physicae*; *Com. Acad. Petrop.* i.; *Com. Acad. Petrop. Nov.* ii. 200. viii.

THUS we have given an elementary account of the distinguishing properties of air as a heavy and compressible fluid, and of the general phenomena which are immediate consequences of these properties. This we have done in a set of propositions analogous to those which form the doctrines of hydrostatics. It remains to consider it in another point of view, namely, as moveable and inert. The phenomena consequent on these properties are exhibited in the velocities which air acquires by pressure, in the resistance which bodies meet with to their motion through the air, and in the impression which air in motion gives to bodies exposed to its action.

We shall first consider the motions of which air is susceptible when the equilibrium of pressure (whether arising from its weight or its elasticity) is removed; and, in the next place, we shall consider its action on solid bodies exposed to its current, and the resistance which it makes to their motion through it.

In this consideration we shall avoid the extreme of generality, which renders the discussion too abstract and difficult, and adapt our investigation to the circumstances in which compressible fluids (of which air is taken for the representative) are most commonly found. We shall consider air therefore as it is commonly found in accessible situations, as acted on by equal and parallel gravity; and we shall consider it in the same order in which water is treated in a system of hydraulics.

In that science the leading problem is to determine with what velocity the water will move through a given orifice when impelled by some known pressure; and it has been found, that the best form in which this most difficult and intricate proposition can be put, is to determine the velocity of water flowing through this orifice when impelled by its weight alone. Having determined this, we can reduce to this case every question which can be proposed; for, in place of the pressure of any piston or other mover, we can always substitute a perpendicular column of water or air whose weight city shall be equal to the given pressure.

The first problem, therefore, is to determine with what velocity air will rush into a void when impelled by its own weight,

Air in
Motion.

by its weight alone. This is evidently analogous to the hydraulic problem of water flowing out of a vessel.

And here we must be contented with referring our readers to the solutions which have been given of that problem, and the demonstration that it flows with the velocity which a heavy body would acquire by falling from a height equal to the depth of the hole under the surface of the water in the vessel. In whatever way we attempt to demonstrate that proposition, every step, nay, every word, of the demonstration applies equally to the air, or to any fluid whatever. Or, if our readers should wish to see the connection or analogy of the cases, we only desire them to recollect an undoubted maxim in the science of motion, that *when the moving force and the matter to be moved vary in the same proportion, the velocity will be the same*. If therefore there be similar vessels of air, water, oil, or any other fluid, all of the height of a homogeneous atmosphere, they will all run through equal and similar holes with the same velocity; for in whatever proportion the quantity of matter moving through the hole be varied by a variation of density, the pressure which forces it out, by acting in circumstances perfectly similar, varies in the same proportion by the same variation of density.

We must therefore assume it as the leading proposition, that *air rushes from the atmosphere into a void with the velocity which a heavy body would acquire by falling from the top of a homogeneous atmosphere*.

It is known that air is about 840 times lighter than water, and that the pressure of the atmosphere supports water at the height of 33 feet nearly. The height therefore of a homogeneous atmosphere is nearly 33×840 , or 27720 feet. Moreover, to know the velocity acquired by any fall, recollect that a heavy body by falling one foot acquires the velocity of 8 feet per second; and that the velocities acquired by falling thro' different heights are as the square roots of the heights. Therefore, to find the velocity corresponding to any height, expressed in feet per second, multiply the square root of the height by 8. We have therefore in the present instance $V = 8\sqrt{27220} = 8 \times 166,493 = 1332$ feet per second. This therefore is the velocity with which common air will rush into a void; and this may be taken as a standard number in pneumatics, as 16 and 32 are standard numbers in the general science of mechanics, expressing the action of gravity at the surface of the earth.

It is easy to see that greater precision is not necessary in this matter. The height of a homogeneous atmosphere is a variable thing, depending on the temperature of the air. If this reason seems any objection against the use of the number 1332, we may retain $8\sqrt{H}$ in place of it, where H expresses the height of a homogeneous atmosphere of the given temperature. A variation of the barometer makes no change in the velocity, nor in the height of the homogeneous atmosphere, because it is accompanied by a proportional variation in the density of the air. When it is increased $\frac{1}{10}$, for instance, the density is also increased $\frac{1}{10}$; and thus the expelling force and the matter to be moved are changed in the same proportion, and the velocity remains the same. N. B. We do not here consider the velocity which the air acquires after its issuing into the void by its continual expansion. This may be ascertained by

the 39th prop. of Newton's *Principia*, b. i. Nay, which appears very paradoxical, if a cylinder of air, communicating in this manner with a void, be compressed by a piston loaded with a weight, which presses it down as the air flows out, and thus keeps it of the same density, the velocity of efflux will still be the same however great the pressure may chance to be: for the first and immediate effect of the load on the piston is to reduce the air in the cylinder to such a density that its elasticity shall exactly balance the load; and because the elasticity of air is proportional to its density, the density of the air will be increased in the same proportion with the load, that is, with the expelling power (for we are neglecting at present the weight of the included air as too inconsiderable to have any sensible effect.) Therefore, since the matter to be moved is increased in the same proportion with the pressure, the velocity will be the same as before.

It is equally easy to determine the velocity with which the air of the atmosphere will rush into a space containing rarer air. Whatever may be the density of this air, its elasticity, which follows the proportion of its density, will balance a proportional part of the pressure of the atmosphere; and it is the excess of this last only which is the moving force. The matter to be moved is the same as before. Let D be the natural density of the air, and δ the density of the air contained in the vessel into which it is supposed to run, and let P be the pressure of the atmosphere, and therefore equal to the force which impels it into a void; and let π be the force with which this rarer air would run into a void.

We have $D : \delta = P : \pi$, and $\pi = \frac{P\delta}{D}$. Now the moving force in the present instance is $P - \pi$, or $P - \frac{P\delta}{D}$.

Lastly, let V be the velocity of air rushing into a void, and v the velocity with which it will rush into this rarefied air.

It is a theorem in the motion of fluids, that the pressures are as the squares of the velocities of efflux.

Therefore $P : P - \frac{P\delta}{D} = V^2 : v^2$. Hence we derive $v^2 = V^2 \times 1 - \frac{\delta}{D}$, and $v = V \times \sqrt{1 - \frac{\delta}{D}}$. We do not

here consider the resistance which the air of the atmosphere will meet with from the inertia of that in the vessel which it must displace in its motion.

Here we see that there will always be a current into the vessel while δ is less than D.

We also learn the gradual diminution of the velocity as the vessel fills; for δ continually increases, and therefore $1 - \frac{\delta}{D}$ continually diminishes.

It remains to determine the time t expressed in seconds, in which the air of the atmosphere will flow into this vessel from its state of vacuity till the air in the vessel has acquired any proposed density δ .

For this purpose let H, expressed in feet, be the height through which a heavy body must fall in order to acquire the velocity V, expressed also in feet per second. This we shall express more briefly in future, by calling it the height producing the velocity V. Let C represent the capacity of the vessel, expressed in cubic feet,

Air in
Motion.28r
And the
velocity
with which
it rushes
into a space
containing
rarer air,

Air in Motion

fect, and O the area or section of the orifice, expressed in superficial or square feet; and let the natural density of the air be D.

Since the quantity of aerial matter contained in a vessel depends on the capacity of the vessel and the density of the air jointly, we may express the air which would fill this vessel by the symbol CD when the air is in its ordinary state, and by C δ when it has the density δ . In order to obtain the rate at which it fills, we must take the fluxion of this quantity C δ . This is C $\dot{\delta}$; for C is a constant quantity, and δ is a variable or flowing quantity.

But we also obtain the rate of influx by our knowledge of the velocity, and the area of the orifice, and the density. The velocity is V, or $8\sqrt{H}$, at the first instant; and when the air in the vessel has acquired the density δ , that is, at the end of the time t , the velocity

$$\text{is } 8\sqrt{H}\sqrt{1-\frac{\delta}{D}}, \text{ or } 8\sqrt{H}\sqrt{\frac{D-\delta}{D}},$$

$$\text{or } 8\sqrt{H}\frac{\sqrt{D-\delta}}{\sqrt{D}}.$$

The rate of influx therefore (which may be conceived as measured by the little mass of air which will enter during the time i with this velocity) will be

$$8\sqrt{HOD}\sqrt{D-\delta}i, \text{ or } 8\sqrt{HO}\sqrt{D}\sqrt{D-\delta}i, \text{ multiplying the velocity by the orifice and by the density.}$$

Here then we have two values of the rate of influx. By stating them as equal we have a fluxionary equation, from which we may obtain the fluents, that is, the time t in seconds necessary for bringing the air in the vessel to the density δ , or the density δ which will be produced at the end of any time t . We have the equation

$$8\sqrt{HO}\sqrt{D}\sqrt{D-\delta}i = C\dot{\delta}. \text{ Hence we derive}$$

$$i = \frac{C}{8\sqrt{HO}\sqrt{D}} \times \frac{\delta}{\sqrt{D-\delta}}. \text{ Of this the fluent is}$$

$$t = \frac{C}{4\sqrt{HO}\sqrt{D}} \times \sqrt{D-\delta} + A, \text{ in which A is a conditional constant quantity. The condition which determines it is, that } t \text{ must be nothing when } \delta \text{ is nothing, that is, when } \sqrt{D-\delta} = \sqrt{D}; \text{ for this is evidently the case at the beginning of the motion. Hence it follows, that the constant quantity is } \sqrt{D}, \text{ and the complete fluent, suited to the case, is}$$

$$\frac{C}{4\sqrt{HO}\sqrt{D}} \times \sqrt{D-\sqrt{D-\delta}}.$$

The motion ceases when the air in the vessel has acquired the density of the external air; that is, when

$$\delta = D, \text{ or when } t = \frac{C}{4\sqrt{HO}\sqrt{D}} \times \sqrt{D}, = \frac{C}{4\sqrt{HO}}.$$

Therefore the time of completely filling the vessel is

$$\frac{C}{4\sqrt{HO}}.$$

Let us illustrate this by an example in numbers.

Supposing then that air is 840 times lighter than water, and the height of the homogeneous atmosphere 27720 feet, we have $4\sqrt{H} = 666$. Let us further suppose the vessel to contain 8 cubic feet, which is nearly a wine hoghead, and that the hole by which the air of the ordinary density, which we shall make = 1, enters is an inch square, or $\frac{1}{144}$ of a square foot. Then

the time in seconds of completely filling it will be

$$\frac{8''}{\frac{1}{144} \times 666}, \text{ or } \frac{1152''}{666}, \text{ or } 1,7297''. \text{ If the hole is only}$$

$\frac{1}{160}$ of a square inch, that is, if its side is $\frac{1}{10}$ of an inch, the time of completely filling the hoghead will be 173'' very nearly, or something less than three minutes.

If we make the experiment with a hole cut in a thin plate, we shall find the time greater nearly in the proportion of 63 to 100, for reasons obvious to all who have studied hydraulics. In like manner we can tell the time necessary for bringing the air in the vessel to $\frac{3}{4}$ of its ordinary density. The only variable part of our fluent is the coefficient $-\sqrt{D-\delta}$, or $\sqrt{1-\frac{\delta}{D}}$. Let δ be $\frac{3}{4}$, then $\sqrt{1-\frac{\delta}{D}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$, and $1-\sqrt{1-\frac{\delta}{D}} = \frac{1}{2}$; and the time is $86\frac{1}{2}''$ very nearly when the hole is $\frac{1}{160}$ of an inch wide.

Let us now suppose that the air in the vessel ABCD (fig. 64.) is compressed by a weight acting on the cover AD, which is moveable down the vessel, and is thus expelled into the external air.

The immediate effect of this external pressure is to compress the air and give it another density. The density D of the external air corresponds to its pressure P. Let the additional pressure on the cover of the vessel be p , and the density of the air in the vessel be d . We shall have $P : P+p = D : d$; and therefore

$$p = P \times \frac{d-D}{D}. \text{ Then, because the pressure which expels the air is the difference between the force which compresses the air in the vessel and the force which compresses the external air, the expelling force is } p. \text{ And because the quantities of motion are as the forces which similarly produce them, we shall have}$$

$$P : P \times \frac{d-D}{D} = MV : mv; \text{ where M and m express the quantities of matter expelled, V expresses the velocity with which air rushes into a void, and } v \text{ expresses the velocity sought. But because the quantities of aerial matter which issue from the same orifice in a moment are as the densities and velocities jointly, we shall have}$$

$$MV : mv = DVV : dvv, = DV^2 : dv^2. \text{ Therefore}$$

$$P : p \times \frac{d-D}{D} = DV^2 : dv^2. \text{ Hence we deduce}$$

$$v = V \sqrt{\frac{d-D}{D}}.$$

We may have another expression of the velocity without considering the density. We had $P : P+p = D : d$; therefore

$$d = \frac{D \times P+p}{P}, \text{ and } d-D = \frac{D \times P+p}{P} - D,$$

$$= \frac{D \times P+p-DP}{P}, \text{ and } \frac{d-D}{d} = \frac{D \times P+p-DP}{D \times P+p},$$

$$= \frac{P+p-P}{P+p} = \frac{p}{P+p}; \text{ therefore } v = V \times \sqrt{\frac{p}{P+p}},$$

which is a very simple and convenient expression.

Hitherto we have considered the motion of air as produced by its weight only. Let us now consider the effect of its elasticity.

Let ABCD (fig. 64.) be a vessel containing air of any density D. This air is in a state of compression; and if the compressing force be removed, it will expand, and its elasticity will diminish along with its density.

Plate CCCC

287 The velocity of air with the impulse of a weight moving down the vessel.

288 The effect of the air's elasticity considered.

Its elasticity in any state is measured by the force which keeps it in that state. The force which keeps common air in its ordinary density is the weight of the atmosphere, and is the same with the weight of a column of water 33 feet high. If therefore we suppose that this air, instead of being confined by the top of the vessel, is pressed down by a moveable piston carrying a column of water 33 feet high, its elasticity will balance this pressure as it balances the pressure of the atmosphere; and as it is a fluid, and propagates through every part the pressure exerted on any one part, it will press on any little portion of the vessel by its elasticity in the same manner as when loaded with this column.

The consequence of this reasoning is, that if this small portion of the vessel be removed, and thus a passage be made into a void, the air will begin to flow out with the same velocity with which it would flow when impelled by its weight alone, or with the velocity acquired by falling from the top of a homogeneous atmosphere, or 1332 feet in a second nearly.

But as soon as some air has come out, the density of the remaining air is diminished, and its elasticity is diminished; therefore the expelling force is diminished. But the matter to be moved is diminished in the very same proportion, because the density and elasticity are found to vary according to the same law; therefore the velocity will continue the same from the beginning to the end of the efflux.

This may be seen in another way. Let P be the pressure of the atmosphere, which being the counterbalance and measure of the initial elasticity, is equal to the expelling force at the first instant. Let D be the initial density, and V the initial velocity. Let d be its density at the end of the time t of efflux, and v the contemporaneous velocity. It is plain that at the end of this time we shall have the expelling force $\pi = \frac{Pd}{D}$;

for $D : d = P : \pi \left(= \frac{Pd}{D} \right)$.

These forces are proportional to the quantities of motion which they produce; and the quantities of motion are proportional to the quantities of matter M and m and the velocities V and v jointly: therefore we have $P : \frac{Pd}{D} = MV : mv$. But the quantities of matter which escape through a given orifice are as the densities and velocities jointly; that is, $M : m = DV : dv$: therefore $P : \frac{Pd}{D} = DV^2 : dv^2$, and $P \times dv^2 = \frac{PdDV^2}{D} = PdV^2$, and $V^2 = v^2$, and $V = v$, and the velocity of efflux is constant. Hence follows, what appears very unlikely at first sight, that however much the air in the vessel is condensed, it will always issue into a void with the same velocity.

289
Quantity
of air issu-
ing into a
void in a
given time,
and the
density at
the end of
that time.

In order to find the quantity of aerial matter which will issue during any time t , and consequently the density of the remaining air at the end of this time, we must get the rate of efflux. In the element of time i there issues (by what has been said above) the bulk $8\sqrt{HO}di$ (for the velocity V is constant); and therefore the quantity $8\sqrt{HO}di$. On the other hand, the quantity of air at the beginning was CD , C being the capacity of the vessel; and when the air has acquired the density d , the quantity is Cd , and the quantity

run out is $CD - Cd$: therefore the quantity which has run out in the time i must be the fluxion of $CD - Cd$, or $-Cd$. Therefore we have the equation $8\sqrt{HO}di = -Cd$, and $i = \frac{-Cd}{8\sqrt{HO}d} = \frac{C}{8\sqrt{HO}} \times -\frac{d}{d}$.

The fluent of this is $t = \frac{C}{8\sqrt{HO}} \log. d$. This fluent must be so taken that t may be $= 0$ when $d = D$. Therefore the correct fluent will be $t = \frac{C}{8\sqrt{HO}} \log. \frac{D}{d}$, for $\log. \frac{D}{D} = \log. 1 = 0$. We deduce from this, that it

requires an infinite time for the whole air of a vessel to flow out of it into a void. N. B. By $\log. d$, &c. is meant the hyperbolic logarithm of d , &c.

Let us next suppose that the vessel, instead of letting out its air into a void, emits it into air of a less density, which remains constant during the efflux, as we may suppose to be the case when a vessel containing condensed air emits it into the surrounding atmosphere. Let the initial density of the air in the vessel be δ , and that of the atmosphere D . Then it is plain

that the expelling force is $P - \frac{PD}{\delta}$, and that after the time t it is $\frac{Pd}{\delta} - \frac{PD}{\delta}$. We have therefore $P - \frac{PD}{\delta} : \frac{Pd}{\delta} - \frac{PD}{\delta} = MV : mv = \delta V^2 : dv^2$. Whence we

derive $v = V \sqrt{\frac{\delta d - D}{\delta D - D}}$

From this equation we learn that the motion will be at an end when $d = D$: and if $\delta = D$ there can be no efflux.

To find the relation between the time and the density, let H as before be the height producing the velocity V . The height producing the velocity of efflux

v must be $H \times \frac{\delta d - D}{\delta D - D}$, and the little parcel of air which will flow out in the time i will be $= 8\sqrt{HO}di$

$\sqrt{\frac{\delta d - D}{\delta D - D}}$. On the other hand, it is $= -Cd$

Hence we deduce the fluxionary equation $i = \frac{C\sqrt{\delta - D}}{8\sqrt{HO}\sqrt{\delta}} \times \frac{-d}{\sqrt{d^2 - D\delta}}$. The fluent of this, corrected so as to make $t = 0$ when $d = \delta$, is $t = \frac{C\sqrt{\delta - D}}{8\sqrt{HO}\sqrt{\delta}}$

$\times \log. \left(\frac{\delta - \frac{1}{2}D + \sqrt{\delta^2 - D\delta}}{d - \frac{1}{2}D + \sqrt{d^2 - D\delta}} \right)$. And the time of

completing the efflux, when $d = D$, is $t = \frac{C\sqrt{\delta - D}}{8\sqrt{HO}\sqrt{\delta}}$

$\times \log. \left(\frac{\delta - \frac{1}{2}D + \sqrt{\delta^2 - D\delta}}{\frac{1}{2}D} \right)$.

Lastly, let $ABCD$, $CFGH$ (fig. 65.) be two vessels containing airs of different densities, and communicating by the orifice C , there will be a current from the vessel containing the denser air into that containing the rarer: suppose from $ABCD$ into $CFGH$.

Let P be the elastic force of the air in $ABCD$, Q its.

Air in Motion

its density, and V its velocity, and D the density of the air in CFGH. And, after the time t , let the density of the air in ABCD be q , its velocity v , and the density of the air in CFGH be s . The expelling

force from ABCD will be $P - \frac{PD}{Q}$ at the first instant, and at the end of the time t it will be $\frac{Pq}{Q} - \frac{Ps}{Q}$. Therefore

we shall have $P - \frac{PD}{Q} : \frac{Pq}{Q} - \frac{Ps}{Q} = QV^2 : qv^2$, which gives

$v = V \times \sqrt{\frac{Q(q-s)}{q(Q-D)}}$, and the motion will cease when $s = q$.

Let A be the capacity of the first vessel, and B that of the second. We have the second equation

$AQ + BD = Aq + Bs$, and therefore $s = \frac{A(Q-q) + BD}{B}$.

Substituting this value of s in the former value of v , we have

$v = V \times \sqrt{\frac{Q[B(q-D) - A(Q-q)]}{qB(Q-D)}}$, which gives

the relation between the velocity v and the density q .

In order to ascertain the time when the air in ABCD has acquired the density q , it will be convenient to abridge the work by some substitutions. Therefore make $Q(B+A) = M$, $BQD + BQ^2 = N$, $BQ -$

$BD = R$ and $\frac{M}{N} = m$. Then, proceeding as before, we

obtain the fluxionary equation $8\sqrt{HO}q\sqrt{\frac{Mq-N}{\sqrt{R}\sqrt{q}}}i =$

$\overline{AQ - Aq} = -Aq$ whence $i = \frac{A\sqrt{R}}{8\sqrt{HO}\sqrt{M}} \times \frac{q}{\sqrt{q^2 - mq}}$

of which the fluent, completed so that $t=0$ when $q=Q$, is $t = \frac{A\sqrt{R}}{8\sqrt{HO}\sqrt{M}} \times \text{Log} \left(\frac{Q - \frac{1}{2}m + \sqrt{(Q^2 - mQ)}}{Q - \frac{1}{2}m + \sqrt{(Q^2 - mQ)}} \right)$

Some of these questions are of difficult solution, and they are not of frequent use in the more important and usual applications of the doctrines of pneumatics, at least in their present form. The cases of greatest use are when the air is expelled from a vessel by an external force, as when bellows are worked, whether of the ordinary form or consisting of a cylinder fitted with a moveable piston. This last case merits a particular consideration; and, fortunately, the investigation is extremely easy.

Let AD fig. 64. be considered as a piston moving downward with the uniform velocity f , and let the area of the piston be n times the area of the hole of efflux, then the velocity of efflux arising from the motion of the piston will be nf . Add this to the velocity V produced by the elasticity of the air in the first question, and the whole velocity will be $V + nf$. It will be the same in the others. The problem is also freed from the consideration of the time of efflux. For this depends now on the velocity of the piston. It is still, however, a very intricate problem to ascertain the relation between the time and the density, even though the piston is moving uniformly; for at the beginning of the motion the air is of common density. As the piston descends, it both expels and compresses the air, and the density of the air in the vessel varies in a very intricate manner, as also its resistance or reaction on the piston. For this reason, a piston which moves uniformly by means of an external force will never make an uniform blast by suc-

Air in Motion

cessive strokes; it will always be weaker at the beginning of the stroke. The best way for securing an uniform blast is to employ the external force only for lifting up the piston, and then to let the piston descend by its own weight. In this way it will quickly sink down, compressing the air, till its density and corresponding elasticity exactly balance the weight of the piston. After this the piston will descend equably, and the blast will be uniform. We shall have occasion to consider this more particularly under the head of *PNEUMATICAL Machines*. These observations and theorems will serve to determine the initial velocity of the air in all important cases of its expulsion. The philosopher will learn the rate of its efflux out of one vessel into another; the chemist will be able to calculate the quantities of the different gases which are employed in the curious experiments of the ingenious but unfortunate Lavoisier on Combustion, and will find them extremely different from what he supposed; the engineer will learn how to proportion the motive force of his machine to the quantity of aerial matter which his bellows must supply. But it is not enough, for this purpose, that the air begin to issue in the proper quantity; we must feel whether it be not affected by the circumstances of its subsequent passage.

All the modifications of motion which are observed ²⁹⁴ Passage of air through pipes, &c. similar to the motion of water in conduits. in water conduits take place also in the passage of air through pipes and holes of all kinds. There is the same diminution of quantity passing through a hole in a thin plate that is observed in water. We know that (abating the small effect of friction) water issues with the velocity acquired by falling from the surface; and yet if we calculate by this velocity and by the area of the orifice, we shall find the quantity of water deficient nearly in the proportion of 63 to 100. This is owing to the water pressing towards the orifice from all sides, which occasions a contraction of the jet. The same thing happens in the efflux of air. Also the motion of water is greatly impeded by all contractions of its passage. These oblige it to accelerate its velocity, and therefore require an increase of pressure to force it through them, and this in proportion to the squares of the velocities. Thus, if a machine working a pump causes it to give a certain number of strokes in a minute, it will deliver a determined quantity of water in that time. Should it happen that the passage of the water is contracted to one half in any part of the machine (a thing which frequently happens at the valves), the water must move through this contraction with twice the velocity that it has in the rest of the passage. This will require four times the force to be exerted on the piston. Nay (which will appear very odd, and is never suspected by engineers), if no part of the passage is narrower than the barrel of the pump, but on the contrary a part much wider, and if the conduit be again contracted to the width of the barrel, an additional force must be applied to the piston to drive the water through this passage, which would not have been necessary if the passage had not been widened in any part. It will require a force equal to the weight of a column of water of the height necessary for communicating a velocity the square of which is equal to the difference of the squares of the velocities of the water in the wide and the narrow part of the conduit.

293 when a vessel expels air by force bellows

Plat. 3CCC

Air in Motion.

295
Air suffers the same retardation along pipes as water, and the necessity of attending to this.

The same thing takes place in the motion of air, and therefore all contractions and dilatations must be carefully avoided, when we want to preserve the velocity unimpaired.

Air also suffers the same retardation in its motion along pipes. By not knowing, or not attending to that, engineers of the first reputation have been prodigiously disappointed in their expectations of the quantity of air which will be delivered by long pipes. Its extreme mobility and lightness hindered them from suspecting that it would suffer any sensible retardation. Dr Papin, a most ingenious man, proposed this as the most effectual method of transferring the action of a moving power to a great distance. Suppose, for instance, that it was required to raise water out of a mine by a water-machine, and that there was no fall of water nearer than a mile's distance. He employed this water to drive a piston, which should compress the air in a cylinder communicating, by a long pipe, with another cylinder at the mouth of the mine. This second cylinder had a piston in it, whose rod was to give motion to the pumps at the mine. He expected, that as soon as the piston at the water-machine had compressed the air sufficiently, it would cause the air in the cylinder at the mine to force up its piston, and thus work the pumps. Doctor Hooke made many objections to the method, when laid before the Royal Society, and it was much debated there. But dynamics was at this time an infant science, and very little understood. Newton had not then taken any part in the business of the society, otherwise the true objections would not have escaped his sagacious mind. Notwithstanding Papin's great reputation as an engineer and mechanic, he could not bring his scheme into use in England; but afterwards, in France and in Germany, where he settled, he got some persons of great fortunes to employ him in this project; and he erected great machines in Auvergne and Westphalia for draining mines. But, so far from being effective machines, they would not even begin to move. He attributed the failure to the quantity of air in the pipe of communication, which must be condensed before it can condense the air in the remote cylinder. This indeed is true, and he should have thought of this earlier. He therefore diminished the size of this pipe, and made his water-machine exhaust instead of condensing, and had no doubt but that the immense velocity with which air rushes into a void would make a rapid and effectual communication of power. But he was equally disappointed here, and the machine at the mine stood still as before.

Near a century after this, a very intelligent engineer attempted a much more feasible thing of this kind at an iron-foundry in Wales. He erected a machine at a powerful fall of water, which worked a set of cylinder bellows, the blow pipe of which was conducted to the distance of a mile and a half, where it was applied to a blast furnace. But notwithstanding every care to make the conducting pipe very air-tight, of great size, and as smooth as possible, it would hardly blow out a candle. The failure was ascribed to the impossibility of making the pipe air-tight. But, what was surprising, above ten minutes elapsed after the action of the pistons in the bellows before the least wind could be perceived at the end of the pipe; whereas the engineer expected an interval of 6 seconds only.

No very distinct theory can be delivered on this subject; but we may derive considerable assistance in understanding the causes of the obstruction to the motion of water in long pipes, by considering what happens to air. The elasticity of the air, and its great compressibility, have given us the distinctest notions of fluidity in general, showing us, in a way that can hardly be controverted, that the particles of a fluid are kept at a distance from each other, and from other bodies, by the corpuscular forces. We shall therefore take this opportunity to give a view of the subject, which did not occur to us when treating of the motion of water in pipes, reserving a further discussion to the articles RIVER, *WATER-Works*.

The writers on hydrodynamics have always considered the obstruction to the motion of fluids along canals of any kind, as owing to something like the friction by which the motion of solid bodies on each other is obstructed; but we cannot form to ourselves any distinct notion of resemblance, or even analogy between them. The fact is, however, that a fluid running along a canal has its motion obstructed; and that this obstruction is greatest in the immediate vicinity of the solid canal, and gradually diminishes to the middle of the stream. It appears, therefore, that the parts of fluids can no more move among each other than among solid bodies, without suffering a diminution of their motion. The parts in physical contact with the sides and bottom are retarded by these immoveable bodies. The particles of the next stratum of fluid cannot preserve their initial velocities without overpassing the particles of the first stratum; and it appears from the fact that they are by this means retarded. They retard in the same manner the particles of the third stratum, and so on to the middle stratum or thread of fluid. It appears from the fact, therefore, that this sort of friction is not a consequence of rigidity alone, but that it is equally competent to fluids. Nay, since it is a matter of fact in air, and is even more remarkable there than in any other fluid, as we shall see by the experiments which have been made on the subject; and as our experiments on the compression of air show us the particles of air ten times nearer to each other in some cases than in others (viz. when we see air a thousand times denser in these cases), and therefore force us to acknowledge that they are not in contact; it is plain that this obstruction has no analogy to friction, which supposes roughness or inequality of surface. No such inequality can be supposed in the surface of an aerial particle; nor would it be of any service in explaining the obstruction, since the particles do not rub on each other, but pass each other at some small and imperceptible distance.

We must therefore have recourse to some other mode of explication. We shall apply this to air only in this place; and, since it is proved by the uncontrovertible experiments of Canton, Zimmerman, and others, that water, mercury, oil, &c. are also compressible and perfectly elastic, the argument from this principle, which is conclusive in air, must equally explain the similar phenomenon in hydraulics.

The most highly polished body which we know must be conceived as having an uneven surface when we compare it with the small spaces in which the corpuscular forces are exerted; and a quantity of air moving

Air in Motion.
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No distinct theory on this subject

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How fluids are obstructed in moving canals.

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Air in
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in a polished pipe may be compared to a quantity of small shot sliding down a channel with undulated sides and bottom. The row of particles immediately contiguous to the sides will therefore have an undulated motion: but this undulation of the contiguous particles of air will not be so great as that of the surface along which they glide; for not only every motion requires force to produce it, but also every change of motion. The particles of air resist this change from a rectilinear to an undulating motion; and, being elastic, that is, repelling each other and other bodies, they keep a little nearer to the surface as they are passing over an eminence, and their path is less incurvated than the surface. The difference between the motion of the particles of air and the particles of a fluid quite unelastic is, in this respect, somewhat like the difference between the motion of a spring-carriage and that of a common carriage. When the common carriage passes along a road not perfectly smooth, the line described by the centre of gravity of the carriage keeps perfectly parallel to that described by the axis of the wheels, rising and falling along with it. Now let a spring body be put on the same wheels and pass along the same road. When the axis rises over an eminence perhaps half an inch, sinks down again into the next hollow, and then rises a second time, and so on, the centre of gravity of the body describes a much straighter line; for upon the rising of the wheels, the body resists the motion, and compresses the springs, and thus remains lower than it would have been had the springs not been interposed. In like manner, it does not sink so low as the axle does when the wheels go into a hollow. And thus the motion of spring-carriages becomes less violently undulated than the road along which they pass. This illustration will, we hope, enable the reader to conceive how the deviation of the particles next to the sides and bottom of the canal from a rectilinear motion is less than that of the canal itself.

298
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It is evident that the same reasoning will prove that the undulation of the next row of particles will be less than that of the first, that the undulation of the third row will be less than that of the second, and so on, as is represented in fig. A. Plate CCCCIV. And thus it appears, that while the mass of air has a progressive motion along the pipe or canal, each particle is describing a waving line, of which a line parallel to the direction of the canal is the axis, cutting all these undulations. This axis of each undulated path will be straight or curved as the canal is, and the excursions of the path on each side of its axis will be less and less as the axis of the path is nearer to the axis of the canal.

299
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Let us now see what *sensible* effect this will have; for all the motion which we here speak of is imperceptible. It is demonstrated in mechanics, that if a body moving with any velocity be deflected from its rectilinear path by a curved and perfectly smooth channel, to which the rectilinear path is a tangent, it will proceed along this channel with undiminished velocity. Now the path, in the present case, may be considered as perfectly smooth, since the particles do not touch it. It is one of the undulations which we are considering, and we may at present conceive this as without any subordinate inequalities. There should not, therefore, be any diminution of the velocity. Let us grant this of the absolute ve-

VOL. XV. Part I.

locity of the particle; but what we observe is the velocity of the mass, and we judge of it perhaps by the motion of a feather carried along by it. Let us suppose a single atom to be a sensible object, and let us attend to two such particles, one at the side, and the other in the middle: although we cannot perceive the undulations of these particles during their progressive motions, we see the progressive motions themselves. Let us suppose then that the middle particle has moved without any undulation whatever, and that it has advanced ten feet. The lateral particle will also have moved ten feet; but this has not been in a straight line. It will not be so far advanced, therefore, in the direction of the canal; it will be left behind, and will appear to us to have been retarded in its motion: and in like manner each thread of particles will be more and more retarded (apparently only) as it recedes farther from the axis of the canal, or what is usually called the thread of the stream.

And thus the observed fact is shown to be a necessary consequence of what we know to be the nature of a compressible or elastic fluid; and that without supposing any diminution in the real velocity of each particle, there will be a diminution of the velocity of the sensible threads of the general stream, and a diminution of the whole quantity of air which passes along it during a given time.

Let us now suppose a parcel of air impelled along a pipe, which is *perfectly* smooth, out of a larger vessel, and issuing from this pipe with a certain velocity. It requires a certain force to change its velocity in the vessel to the greater velocity which it has in the pipe. This is abundantly demonstrated. How long soever we suppose this pipe, there will be no change in the velocity, or in the force to keep it up. But let us suppose that about the middle of this pipe there is a part of it which has suddenly got an undulated surface, however imperceptible. Let us further suppose that the final velocity of the middle thread is the same as before. In this case it is evident that the sum total of the motions of all the particles is greater than before, because the absolute motions of the lateral particles is greater than that of the central particle, which we suppose the same as before. This absolute increase of motion cannot be without an increase of propelling force: the force acting now, therefore, must be greater than the force acting formerly. Therefore, if only the former force had continued to act, the same motion of the central particle could not have been preserved, or the progressive motion of the whole stream must be diminished.

And thus we see that this internal insensible undulatory motion becomes a real obstruction to the sensible motion which we observe, and occasions an expence of power.

Let us see what will be the consequence of extending this obstructing surface further along the canal. It must evidently be accompanied by an augmentation of the motion produced, if the central velocity be still kept up; for the particles which are now in contact with the sides do not continue to occupy that situation: the middle particles moving faster *forward* get over them, and in their turn come next the side; and as they are really moving equally fast, but not in the direction into which they are now to be forced, force is necessary

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But on the
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An addi-
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Air in Motion.

302
Especially through any contraction.

303
There are besides other obstructions, as angular asperities, &c.

304
And a want of perfect fluidity.

305
The law of retardation extending from the axis to the sides of the canal unknown.

necessary for changing the direction also; and this is in addition to the force necessary for producing the undulations so minutely treated of. The consequence of this must be, that an additional force will be necessary for preserving a given progressive motion in a longer *obstructing* pipe, and that the motion produced in a pipe of greater length by a given force will be less than in a shorter one, and the efflux will be diminished.

There is another consideration which must have an influence here. Nothing is more irrefragably demonstrated than the necessity of an additional force for producing an efflux through any contraction, even though it should be succeeded by a dilatation of the passage. Now both the inequalities of the sides and the undulations of the motions of each particle are equivalent to a succession of contractions and dilatations; although each of these is next to infinitely small; their number is also next to infinitely great, and therefore the total effect may be sensible.

We have hitherto supposed that the absolute velocity of the particles was not diminished: this we did, having assumed that the interval of each undulation of the sides was without inequalities. But this was gratuitous: it was also gratuitous that the sides were only undulated. We have no reason for excluding angular asperities. These will produce, and most certainly often produce, real diminutions in the velocity of the contiguous particles; and this must extend to the very axis of the canal, and produce a diminution of the sum total of motion: and in order to preserve the same sensible progressive motion, a greater force must be employed. This is all that can be meant by saying that there is a resistance to the motion of air through long pipes.

There remains another cause of diminution, viz. the want of perfect fluidity, whether arising from the dissemination of solid particles in a real fluid, or from the viscosity of the fluid. We shall not insist on this at present, because it cannot be shown to obtain in air, at least in any case which deserves consideration. It seems of no importance to determine the motion of air hurrying along with it foot or dust. The effect of fogs on a particular modification of the motion of air will be considered under the article SOUND. What has been said on this subject is sufficient for our purpose, as explaining the prodigious and unexpected obstruction to the passage of air through long and narrow pipes. We are able to collect an important maxim from it, viz. that all pipes of communication should be made as wide as circumstances will permit: for it is plain that the obstruction depends on the internal surface, and the force to overcome it must be in proportion to the mass of matter which is in motion. The first increases as the diameter of the pipe, and the last as the square. The obstruction must therefore bear a greater proportion to the whole motion in a small pipe than in a large one.

It were very desirable to know the law by which the retardation extends from the axis to the sides of the canal, and the proportion which subsists between the lengths of canal and the forces necessary for overcoming the obstructions when the velocity is given; as also whether the proportion of the obstruction to the whole motion varies with the velocity: but all this is unknown. It does not, however, seem a desperate case in air: we know pretty distinctly the law of action among its par-

ticles, viz. that their mutual repulsions are inversely as their distances. This promises to enable us to trace the progress of undulation from the sides of the canal to the axis.

We can see that the retardations will not increase so fast as the square of the velocity. Were the fluid incompressible, so that the undulatory path of a particle were invariable, the deflecting forces by which each individual particle is made to describe its undulating path would be precisely such as arise from the path itself and the motion in it; for each particle would be in the situation of a body moving along a fixed path. But in a very compressible fluid, such as air, each particle may be considered as a solitary body, actuated by a projectile and a transverse force, arising from the action of the adjoining particles. Its motion must depend on the adjustment of these forces, in the same manner as the elliptical motion of a planet depends on the adjustment of the force of projection, with a gravitation inversely proportional to the square of the distance from the focus. The transverse force in the present case has its origin in the pressure on the air which is propelling it along the pipe: this, by squeezing the particles together, brings their mutual repulsion into action. Now it is the property of a perfect fluid, that a pressure exerted on any part of it is propagated equally through the whole fluid; therefore the transverse forces which are excited by this pressure are proportional to the pressure itself: and we know that the pressures exerted on the surface of a fluid, so as to expel it through any orifice, or along any canal, are proportional to the squares of the velocities which they produce. Therefore, in every point of the undulatory motion of any particle, the transverse force by which it is deflected into a curve is proportional to the square of its velocity. When this is the case, a body would continue to describe the same curve as before; but, by the very compression, the curvatures are increased, supposing them to remain similar. This would require an increase of the transverse forces; but this is not to be found: therefore the particle will not describe a similar curve, but one which is less incurved in all its parts; consequently the progressive velocity of the whole, which is the only thing perceivable by us, will not be so much diminished; that is, the obstructions will not increase so fast as they would otherwise do, or as the squares of the velocities.

This reasoning is equally applicable to all fluids, and is abundantly confirmed by experiments in hydraulics, as we shall see when considering the motion of rivers. We have taken this opportunity of delivering our notions on this subject; because, as we have often said, it is in the avowed discrete constitution of air that we see most distinctly the operation of those natural powers which constitute fluidity in general.

We would beg leave to mention a form of experiment for discovering the law of retardation with considerable accuracy. Experiments have been made on pipes and canals. Mr Boffut, in his *Hydrodynamique*, has given a very beautiful set made on pipes of an inch and two inches diameter, and 200 feet long: but although these experiments are very instructive, they do not give us any rule by which we can extend the result to pipes of greater length and different diameters.

Let a smooth cylinder be set upright in a very large vessel or pond, and be moveable round its axis: let it be turned

Air in Motion.

306
It will not increase so fast as the square of the velocities.

307
M. Boffut's experiments on pipes and canals.

Plate CCCCV.

Velocity of Wind. turned round by means of a wheel and pulley with an uniform motion and determined velocity. It will exert the same force on the contiguous water which would be exerted on it by water turning round it with the same velocity: and as this water would have its motion gradually retarded by the fixed cylinder, so the moving cylinder will gradually communicate motion to the surrounding water. We should observe the water gradually dragged round by it; and the vortex would extend farther and farther from it as the motion is continued, and the velocities of the parts of the vortex will be less and less as we recede from the axis. Now, we apprehend, that when a point of the surface of the cylinder has moved over 200 feet, the motion of the water at different distances from it will be similar and proportional to, if not precisely the same with, the retardations of water flowing 200 feet at the same distance from the side of a canal: at any rate, the two are susceptible of an accurate comparison, and the law of retardation may be accurately deduced from observations made on the motions of this vortex.

308 Air in motion is a very familiar object of observation; and it is interesting. In all languages it has got a name; we call it wind: and it is only upon reflection that we consider air as wind in a quiescent state. Many persons hardly know what is meant when air is mentioned; but they cannot refuse that the blast from a bellows is the expulsion of what they contained; and thus they learn that wind is air in motion.

309 The velocity of wind; but no good and unexceptionable method has been contrived for this purpose. The best seems to be by measuring the space passed over by the shadow of a cloud; but this is extremely fallacious. In the first place, it is certain, that although we suppose that the cloud has the velocity of the air in which it is carried along, this is not an exact measure of the current on the surface of the earth; we may be almost certain that it is greater: for air, like all other fluids, is retarded by the sides and bottom of the channel in which it moves. But, in the next place, it is very gratuitous to suppose, that the velocity of the cloud is the velocity of the stratum of air between the cloud and the earth; we are almost certain that it is not. It is abundantly proved by Dr Hutton of Edinburgh, that clouds are always formed when two parcels of air of different temperatures mix together, each containing a proper quantity of vapour in the state of chemical solution. We know that different strata of air will frequently flow in different directions for a long time. In 1781 while a great fleet rendezvoused in Leith Roads during the Dutch war, there was a brisk easterly wind for about five weeks; and, during the last fortnight of this period, there was a brisk westerly current at the height of about $\frac{3}{4}$ of a mile. This was distinctly indicated by frequent fleecy clouds at a great distance above a lower stratum of these clouds, which were driving all this time from the eastward. A gentleman who was at the siege of Quebec in 1759, informed us, that one day while there blew a gale from the west, so hard that the ships at anchor in the river were obliged to strike their topmasts, and it was with the utmost difficulty that some well manned boats could row against it, carrying some artillery stores to a post above the town, several shells were thrown from the town to destroy the boats: one of the shells burst in the air near the top of its flight, which was about half a

Velocity of Wind. mile high. The smoke of this bomb remained in the same spot for above a quarter of an hour, like a great round ball, and gradually dissipated by diffusion, without removing many yards from its place. When, therefore, two strata of air come from different quarters, and one of them flows over the other, it will be only in the contiguous surfaces that a precipitation of vapour will be made. This will form a thin fleecy cloud; and it will have a velocity and direction which neither belongs to the upper nor to the lower stratum of air which produced it. Should one of these strata come from the east and the other from the west with equal velocities, the cloud formed between them will have no motion at all; should one come from the east, and the other from the north, the cloud will move from the north-east with a greater velocity than either of the strata. So uncertain then is the information given by the clouds either of the velocity or the direction of the wind. A thick smoke from a furnace will give us a much less equivocal measure: and this, combined with the effects of the wind in impelling bodies, or deflecting a loaded plane from the perpendicular, or other effects of this kind, may give us measures of the different currents of wind with a precision sufficient for all practical uses.

310 The celebrated engineer Mr John Smeaton has given, The result of Smeaton's observation in the 5th volume of the Philosophical Transactions, the velocities of wind corresponding to the usual denominations in our language. These are founded on a great number of observations made by himself in the course of his practice in erecting wind-mills. They are contained in the following table.

Miles per hour.	Feet per second.	Names.
1	1,47	Light airs.
2	2,93	
3	4,40	
4	5,87	
5	7,33	Breeze.
10	14,67	
15	22,	Brisk gale.
20	29,34	
25	36,67	Fresh gale.
30	44,01	
35	51,34	Strong gale.
40	58,68	
45	66,01	Hard gale.
50	73,35	
60	88,02	Storm.
80	117,36	
100	146,70	

See also some valuable experiments by him on this subject, Philosophical Transactions 1760 and 1761.

311 One of the most ingenious and convenient methods Account of Dr Lynd's anemometer. for measuring the velocity of the wind is to employ its pressure in supporting a column of water, in the same way as Mr Pitot measures the velocity of a current of water. We believe that it was first proposed by Dr James Lynd of Windsor, a gentleman eminent for his great knowledge in all the branches of natural science, and for his ingenuity in every matter of experiment or practical application.

His anemometer (as these instruments are called) consists of a glass tube of the form ABCD (fig. 66.), open at

Plate CCCCV.

Velocity of
Wind

at both ends, and having the branch AB at right angles to the branch CD. This tube contains a few inches of water or any fluid (the lighter the better); it is held with the part CD upright, and AB horizontal and in the direction of the wind; that is, with the mouth A fronting the wind. The wind acts in the way of pressure on the air in AB, compresses it, and causes it to press on the surface of the liquor; forcing it down to F, while it rises to E in the other leg. The velocity of the wind is concluded from the difference Ef between the heights of the liquor in the legs. As the wind does not generally blow with uniform velocity, the liquor is apt to dance in the tube, and render the observation difficult and uncertain: to remedy this, it is proper to contract very much the communication at C between the two legs. If the tube has half an inch of diameter (and it should not have less), a hole of $\frac{1}{8}$ of an inch is large enough; indeed the hole can hardly be too small, nor the tubes too large.

312
It is ingenious and
useful.

This instrument is extremely ingenious, and will undoubtedly give the proportions of the velocities of different currents with the greatest precision; for in whatever way the pressure of wind is produced by its motion, we are certain that the different pressures are as the squares of the velocities: if, therefore, we can obtain one certain measure of the velocity of the wind, and observe the degree to which the pressure produced by it raises the liquor, we can at all other times observe the pressures and compute the velocities from them, making proper allowances for the temperature and the height of the mercury in the barometer; because the velocity will be in the subduplicate ratio of the density of the air inversely when the pressure is the same.

It is usually concluded, that the velocity of the wind is that which would be acquired by falling from a height which is to Ef as the weight of water is to that of an equal bulk of air. Thus, supposing air to be 840 times lighter than water, and that Ef is $\frac{1}{8}$ of an inch, the velocity will be about 63 feet *per* second, which is that of a very hard gale, approaching to a storm. Hence we see by the bye, that the scale of this instrument is extremely short, and that it would be a great improvement of it to make the leg CD not perpendicular, but very much sloping; or perhaps the following form of the instrument will give it all the perfection of which it is capable. Let the horizontal branch AB (fig. 67.) be contracted at B, and continued horizontally for several inches BG of a much smaller bore, and then turned down for two or three inches GC, and then upwards with a wide bore. To use the instrument, hold it with the part DC perpendicular; and (having sheltered the mouth A from the wind) pour in water at D till it advances along GB to the point B, which is made the beginning of the scale; the water in the upright branch standing at f in the same horizontal line with BG. Now, turn the mouth A to the wind; the air in AB will be compressed and will force the water along BG to F, and cause it to rise from f to E; and the range fE will be to the range BF on the scale as the section of the tube BG to that of CD. Thus, if the width of DC be $\frac{1}{2}$ an inch, and that of BG $\frac{1}{8}$, we shall have 25 inches in the scale for one inch of real pressure Ef.

But it has not been demonstrated in a very satisfactory manner, that the velocity of the wind is that acquired by falling through the height of a column of air whose

weight is equal to that of the column of water Ef. Experiments made with Pitot's tube in currents of water show that several corrections are necessary for concluding the velocity of the current from the elevations in the tube: these corrections may however be made, and safely applied to the present case; and then the instrument will enable us to conclude the velocity of the wind immediately, without any fundamental comparison of the elevation, with a velocity actually determined upon other principles. The chief use which we have for this information is in our employment of wind as an impelling power, by which we can actuate machinery or navigate ships. These are very important applications of pneumatical doctrines, and merit a particular consideration; and this naturally brings us to the last part of our subject, viz. the consideration of the impulse of air on bodies exposed to its action, and the resistance which it opposes to the passage of bodies through it.

This is a subject of the greatest importance; being the foundation of that art which has done the greatest honour to the ingenuity of man, and the greatest service to human society, by connecting together the most distant inhabitants of this globe, and making a communication of benefits which would otherwise have been impossible; we mean the art of Navigation or Seamanship. Of all the machines which human art has constructed, a ship is not only the greatest and most magnificent, but also the most ingenious and intricate; and the clever seaman possesses a knowledge founded on the most difficult and abstruse doctrines of mechanics. The seaman probably cannot give any account of his own science; and he possesses it rather by a kind of intuition than by any process of reasoning: but the success and efficacy of all the mechanism of this complicated engine, and the propriety of all the manœuvres which the seaman practises, depend on the invariable laws of mechanics; and a thorough knowledge of these would enable an intelligent person not only to understand the machine and the manner of working it, but to improve both.

Unfortunately this is a subject of very great difficulty; and although it has employed the genius of Newton, and he has considered it with great care, and his followers have added more to his labours on this subject than on any other, it still remains in a very imperfect state.

A minute discussion of this subject cannot therefore be expected in a work like this: we must content ourselves with such a general statement of the most approved doctrine on the subject as shall enable our readers to conceive it distinctly, and judge with intelligence and confidence of the practical deductions which may be made from it.

It is evidently a branch of the general theory of impulse and resistance of fluids, which should have been treated of under the article HYDRAULICS, but was then deferred till the mechanical properties of compressible fluids should also be considered. It was thought very reasonable to suppose that the circumstances of elasticity would introduce the same changes in the impulse and resistance of fluids that it does in solid bodies. It would greatly divert the attention from the distinctive properties of air, if we should in this place enter on this subject, which is both extensive and difficult. We reckon it better therefore to take the whole together: this we shall do under the article RESISTANCE of Fluids, and confine ourselves at present to what relates to the impulse

Velocity of impulse and resistance of air alone; anticipating a few of the general propositions of that theory, but without demonstration, in order to understand the applications which may be made of it.

Suppose then a plane surface, of which aC (fig. 68.) is the section, exposed to the action of a stream of wind blowing in the direction QC , perpendicular to aC . The motion of the wind will be obstructed, and the surface aC pressed forward. And as all impulse or pressure is exerted in a direction perpendicular to the surface, and is resisted in the opposite direction, the surface will be impelled in the direction CD , the continuation of QC . And as the mutual actions of bodies depend on their relative motions, the force acting on the surface aC will be the same, if we shall suppose the air at rest, and the surface moving equally swift in the opposite direction. The resistance of the air to the motion of the body will be equal to the impulse of the air in the former case. Thus resistance and impulse are equal and contrary.

If the air be moving twice as fast, its particles will give a double impulse; but in this case a double number of particles will exert their impulse in the same time: the impulse will therefore be fourfold; and in general it will be as the square of the velocity: or if the air and body be both in motion, the impulse and resistance will be proportional to the square of the relative velocity.

This is the first proposition on the subject, and it appears very consonant to reason. There will therefore be some analogy between the force of the air's impulse or the resistance of a body, and the weight of a column of air incumbent on the surface: for it is a principle in the action of fluids, that the heights of the columns of fluid are as the squares of the velocities which their pressures produce. Accordingly the second proposition is, that the absolute impulse of a stream of air, blowing perpendicularly on any surface, is equal to the weight of a column of air which has that surface for its base, and for its height the space through which a body must fall in order to acquire the velocity of the air.

Thirdly, Suppose the surface AC equal to aC no longer to be perpendicular to the stream of air, but inclined to it in the angle ACD , which we shall call the *angle of incidence*; then, by the resolution of forces, it follows, that the action of each particle is diminished in the proportion of radius to the sine of the angle of incidence, or of AC to AL , AL being perpendicular to CD .

Again: Draw AK parallel to CD . It is plain that no air lying farther from CD than KA is will strike the plane. The quantity of impulse therefore is diminished still farther in the proportion of aC to KC , or of AC to AL . Therefore, on the whole, the absolute impulse is diminished in the proportion of AC^2 to AL^2 : hence the proposition, that the impulse and resistance of a given surface are in the proportion of the square of the sine of the angle of incidence.

Fourthly, This impulse is in the direction PL , perpendicular to the impelled surface, and the surface tends to move in this direction: but suppose it moveable only in some other direction PO , or that it is in the direction PO that we wish to employ this impulse, its action is therefore oblique; and if we wish to know the intensity of the impulse in this direction, it must be diminished still farther in the proportion of radius to the cosine of the

angle LPO or sine of CPO . Hence the general proposition: *The effective impulse is as the surface, as the square of the velocity of the wind, as the square of the sine of the angle of incidence, and as the sine of the obliquity jointly*, which we may express by the symbol $R = S \cdot V^2 \cdot \sin^2 I \cdot \sin O$; and as the impulse depends on the density of the impelling fluid, we may take in every circumstance by the equation $R = S \cdot D \cdot V^2 \cdot \sin^2 I \cdot \sin O$. If the impulse be estimated in the direction of the stream, the angle of obliquity ACD is the same with the angle of incidence, and the impulse in this direction is as the surface, as the square of the velocity, and as the cube of the angle of incidence jointly.

It evidently follows from these premises, that if ACA' be a wedge, of which the base AA' is perpendicular to the wind, and the angle ACA' bisected by its direction, the direct or perpendicular impulse on the base is to the oblique impulse on the sides as radius to the square of the sine of half the angle ACA' .

The same must be affirmed of a pyramid or cone ACA' , of which the axis is in the direction of the wind.

If ACA' (fig. 69.) represent the section of a solid, produced by the revolution of a curve line APC round the axis CD , which lies in the direction of the wind, the impulse on this body may be compared with the direct impulse on its base, or the resistance to the motion of this body through the air may be compared with the direct resistance of its base, by resolving its surface into elementary planes Pp , which are coincident with a tangent plane PR , and comparing the impulse on Pp with the direct impulse on the corresponding part Kk of the base.

In this way it follows that the impulse on a sphere is one half of the impulse on its great circle, or on the base of a cylinder of equal diameter.

We shall conclude this sketch of the doctrine with a very important proposition to determine the most advantageous position of a plane surface, when required to move in one direction while it is impelled by the wind blowing in a different direction. Thus,

Let AB (fig. 70.) be the sail of a ship, CA the direction in which the wind blows, and AD the line of the ship's course. It is required to place the yard AC in such a position that the impulse of the wind upon the sail may have the greatest effect possible in impelling the ship along AD .

Let $AB, A b$, be two positions of the sail very near the best position, but on opposite sides of it. Draw BE, be , perpendicular to CA , and BF, bf , perpendicular to AD , calling AB radius; it is evident that BE, BF , are the sines of impulse and obliquity, and that the effective impulse is $BE^2 \times BF$, or $be^2 \times bf$. This must be a maximum.

Let the points B, b , continually approach and ultimately coincide; the chord bB will ultimately coincide with a straight line CBD touching the circle in B ; the triangles CBE, cbe are similar, as also the triangles DBF, Dbf : therefore $BE^2 : be^2 = BC^2 : bc^2$, and $BF : bf = BD : bD$; and $BE^2 \times BF : be^2 \times bf = CB^2 \times BD : cb^2 \times bD$. Therefore when AB is in the best position, so that $BE^2 \times BF$ is greater than $be^2 \times bf$, we shall have $CB \times BD$ greater than $Cb \times bD$, or $CB^2 \times BD$ is also a maximum. This we know to be the case when $CB = 2BD$: therefore the sail must be so placed that

Velocity of
Wind.

the tangent of the angle of incidence shall be double of the tangent of the angle of the sail and keel.

In a common windmill the angle CAD is necessarily a right angle; for the sail moves in a circle to which the wind is perpendicular: therefore the best angle of the sail and axle will be $54^{\circ}.44$ nearly.

Such is the theory of the resistance and impulse of the air. It is extremely simple and of easy application. In all physical theories there are assumptions which depend on other principles, and those on the judgment of the naturalist; so that it is always proper to confront the theory with experiment. There are even circumstances in the present case which have not been attended to in the theory. When a stream of air is obstructed by a solid body, or when a solid body moves along in air, the air is condensed before it and rarefied behind. There is therefore a pressure on the anterior parts arising from this want of equilibrium in the elasticity of the air. This must be superadded to the force arising from the impetus or inertia of the air. We cannot tell with precision what may be the amount of this condensation; it depends on the velocity with which any condensation diffuses itself.

Also, if the motion be so rapid that the pressure of the atmosphere cannot make the air immediately occupy the place quitted by the body, it will sustain this pressure on its forepart to be added to the other forces.

317
Account of
the principal
experiments on
this subject.

Experiments on this subject are by no means numerous; at least such experiments as can be depended on for the foundation of any practical application. The first that have this character are those published by Mr Robins in 1742 in his treatise on Gunnery. They were repeated with some additions by the Chevalier Borda, and some account of them published in the Memoirs of the Academy of Sciences in 1763. In the Philosophical Transactions of the Royal Society of London, Vol. LXXIII. there are some experiments of the same kind on a larger scale by Mr Edgeworth. These were all made in the way described in our account of Mr Robins's improvements in gunnery. Bodies were made to move with determined velocities, and the resistances were measured by weights.

In all these experiments the resistances were found very exactly in the proportion of the squares of the velocities; but they were found considerably greater than the weight of the column of air, whose height would produce the velocity in a falling body. Mr Robins's experiments on a square of 16 inches, describing 25.2 feet per second, indicate the resistance to be to this weight nearly as 4 to 3. Borda's experiments on the same surface state the disproportion still greater.

The resistances are found not to be in the proportion of the surfaces, but increase considerably faster. Surfaces of 9, 16, 36, and 81 inches, moving with one velocity, had resistances in the proportion of 9, $17\frac{1}{2}$, $42\frac{1}{2}$, and $104\frac{1}{2}$.

Now as this deviation from the proportion of the surfaces increases with great regularity, it is most probable that it continues to increase in surfaces of still greater extent; and these are the most generally to be met with in practice in the action of wind on ships and mills.

Borda's experiments on 81 inches show that the impulse of wind moving one foot per second is about $\frac{1}{500}$ of a pound on a square foot. Therefore to find the impulse on a foot corresponding to any velocity, divide

the square of the velocity by 500, and we obtain the Velocity impulse in pounds. Mr Rouse of Leicestershire made many experiments, which are mentioned with great approbation by Mr Smeaton. His great sagacity and experience in the erection of windmills oblige us to pay a considerable deference to his judgment. These experiments confirm our opinion, that the impulses increase faster than the surfaces. The following table was calculated from Mr Rouse's observations, and may be considered as pretty near the truth.

Velocity in Feet.	Impulse on a Foot in Pounds.
0	0,000
10	0,229
20	0,915
30	2,059
40	3,660
50	5,718
60	8,234
70	11,207
80	14,638
90	18,526
100	22,872
110	27,675
120	32,926
130	38,654
140	44,830
150	51,462

If we multiply the square of the velocity in feet by 16, the product will be the impulse or resistance on a square foot in grains, according to Mr Rouse's numbers.

The greatest deviation from the theory occurs in the oblique impulses. Mr Robins compared the resistance of a wedge, whose angle was 90° , with the resistance of its base; and instead of finding it less in the proportion of $\sqrt{2}$ to 1, as determined by the theory, he found it greater in the proportion of 55 to 68 nearly; and when he formed the body into a pyramid, of which the sides had the same surface and the same inclination as the sides of the wedge, the resistance of the base and face were now as 55 to 39 nearly: so that here the same surface with the same inclination had its resistance reduced from 68 to 39 by being put into this form. Similar deviations occur in the experiments of the Chevalier Borda; and it may be collected from both, that the resistances diminish more nearly in the proportion of the sines of incidence than in the proportion of the squares of those sines.

The irregularity in the resistance of curved surfaces is as great as in plane surfaces. In general, the theory gives the oblique impulses on plane surfaces much too small, and the impulses on curved surfaces too great. The resistance of a sphere does not exceed the fourth part of the resistance of its great circle, instead of being its half; but the anomaly is such as to leave hardly any room for calculation. It would be very desirable to have the experiments on this subject repeated in a greater variety of cases, and on larger surfaces, so that the errors of the experiments may be of less consequence. Till this matter be reduced to some rule, the art of working ships must remain very imperfect, as must also the construction of windmills.

The case in which we are most interested in the know-

knowledge of the resistance of the air is the motion of bullets and shells. Writers on artillery have long been sensible of the great effect of the air's resistance. It seems to have been this consideration that chiefly engaged Sir Isaac Newton to consider the motions of bodies in a resisting medium. A proposition or two would have sufficed for showing the incompatibility of the planetary motions with the supposition that the celestial spaces were filled with a fluid matter; but he has with great solicitude considered the motion of a body projected on the surface of the earth, and its deviation from the parabolic track assigned by Galileo. He has bestowed more pains on this problem than any other in his whole work; and his investigation has pointed out almost all the improvements which have been made in the application of mathematical knowledge to the study of nature. Nowhere does his sagacity and fertility of resource appear in so strong a light as in the second book of the *Principia*, which is almost wholly occupied by this problem. The celebrated mathematician John Bernouilli engaged in it as the finest opportunity of displaying his superiority. A mistake committed by Newton in his attempt to a solution was matter of triumph to him; and the whole of his performance, though a piece of elegant and elaborate geometry, is greatly hurt by his continually bringing this mistake (which is a mere trifle) into view. The difficulty of the subject is so great, that subsequent mathematicians seem to have kept aloof from it; and it has been entirely overlooked by the many voluminous writers who have treated professedly on military projectiles. They have spoken indeed of the resistance of the air as affecting the flight of shot, but have saved themselves from the task of investigating this effect (a task to which they were unequal), by supposing that it was not so great as to render their theories and practical deductions very erroneous. Mr Robins was the first who seriously examined the subject. He showed, that even the Newtonian theory (which had been corrected, but not in the smallest degree improved or extended in its principles) was sufficient to show that the path of a cannon ball could not resemble a parabola. Even this theory showed that the resistance was more than eight times the weight of the ball, and should produce a greater deviation from the parabola than the parabola deviated from a straight line.

This simple but singular observation was a strong proof how faulty the professed writers on artillery had been, in rather amusing themselves with elegant but useless applications of easy geometry, than in endeavouring to give their readers any useful information. He added, that the difference between the ranges by the Newtonian theory and by experiment were so great, that the resistance of the air must be vastly superior to what that theory supposed. It was this which suggested to him the necessity of experiments to ascertain this point. We have seen the result of these experiments in moderate velocities; and that they were sufficient for calling the whole theory in question, or at least for rendering it useless. It became necessary therefore to settle every point by means of a direct experiment. Here was a great difficulty. How shall we measure either these great velocities which are observed in the motions of cannon shot, or the resistances which these enormous velocities occasion? Mr Robins had the ingenuity to do both. The method which he took for mea-

suring the velocity of a musket-ball was quite original; and it was susceptible of great accuracy. We have already given an account of it under the article GUNNERY. Having gained this point, the other was not difficult. In the moderate velocities he had determined the resistances by the forces which balanced them, the weights which kept the resisted body in a state of uniform motion. In the great velocities, he proposed to determine the resistances by their immediate effects, by the retardations which they occasioned. This was to be done by first ascertaining the velocity of the ball, and then measuring its velocity after it had passed through a certain quantity of air. The difference of these velocities is the retardation, and the proper measure of the resistance; for, by the initial and final velocities of the ball, we learn the time which was employed in passing through this air with the medium velocity. In this time the air's resistance diminished the velocity by a certain quantity. Compare this with the velocity which a body projected directly upwards would lose in the same time by the resistance of gravity. The two forces must be in the proportion of their effects. Thus we learn the proportion of the resistance of the air to the weight of the ball. It is indeed true, that the time of passing through this space is not accurately had by taking the arithmetical medium of the initial and final velocities, nor does the resistance deduced from this calculation accurately correspond to this mean velocity; but both may be accurately found by the experiment by a very troublesome computation, as is shown in the 5th and 6th propositions of the second book of Newton's *Principia*. The difference between the quantities thus found, and those deduced from the simple process is quite trifling, and far within the limits of accuracy attainable in experiments of this kind; it may therefore be safely neglected.

Mr Robins made many experiments on this subject; ³²⁰ Mr Robins but unfortunately he has published only a very few, made many such as were sufficient for ascertaining the point he had in view. He intended a regular work on the subject, experiments on this sub- in which the gradual variations of resistance corresponding to different velocities should all be determined by experiment: but he was then newly engaged in an important and laborious employment, as chief engineer to the East India Company, in whose service he went out to India, where he died in less than two years. It is to be regretted that no person has prosecuted these experiments. It would be neither laborious nor difficult, and would add more to the improvement of artillery than any thing that has been done since Mr Robins's death, if we except the prosecution of his experiments on the initial velocities of cannon-shot by Dr Charles Hutton royal professor at the Woolwich Academy. It is to be hoped that this gentleman, after having with such effect and success extended Mr Robins's experiments on the initial velocities of musket-shot to cannon, will take up this other subject, and thus give the art of artillery all the scientific foundation which it can receive in the present state of our mathematical knowledge. Till then we must content ourselves with the practical rules which Robins has deduced from his own experiments. As he has not given us the mode of deduction, we must compare the results with experiment. He has indeed given a very extensive comparison with the numerous experiments made both in Britain and

Resistance of Air in Gunnery.

Resistance
of Air in
Gunnery.

and on the continent; and the agreement is very great. His learned commentator Euler has been at no pains to investigate these rules, and has employed himself chiefly in detecting errors, most of which are supposed, because he takes for a finished work what Mr Robins only gives to the public as a hasty but useful sketch of a new and very difficult branch of science.

321
General re-
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them, &c.

The general result of Robins's experiments on the retardation of musket-shot is, that although in moderate velocities the resistance is so nearly in the duplicate proportion of the velocities that we cannot observe any deviation, yet in velocities exceeding 200 feet per second the retardations increase faster, and the deviation from this rate increases rapidly with the velocity. He ascribes this, to the causes already mentioned, viz, the condensation of the air before the ball and to the rarefaction behind, in consequence of the air not immediately occupying the space left by the bullet. This increase is so great, that if the resistance to a ball moving with the velocity of 1700 feet in a second be computed on the supposition that the resistance observed in moderate velocities is increased in the duplicate ratio of the velocity, it will be found hardly one-third part of its real quantity. He found, for instance, that a ball moving thro' 1670 feet in a second lost about 125 feet per second of its velocity in passing through 50 feet of air. This it must have done in the $\frac{1}{11}$ of a second, in which time it would have lost one foot if projected directly upwards; from which it appears that the resistance was about 125 times its weight, and more than three times greater than if it had increased from the resistance in small velocities in the duplicate ratio of the velocities. He relates other experiments which show similar results.

But he also mentions a singular circumstance, that till the velocities exceed 1100 feet per second, the resistances increase pretty regularly, in a ratio exceeding the duplicate ratio of the velocities; but that in greater velocities the resistances become suddenly triple of what they would have been, even according to this law of increase. He thinks this explicable by the vacuum which is then left behind the ball, it being well known that air rushes into a vacuum with the velocity of 1132 feet

322
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per second nearly. Mr Euler controverts this conclusion, as inconsistent with that gradation which is observed in all the operations of nature; and says, that although the vacuum is not produced in smaller velocities than this, the air behind the ball must be so rare (the space being but imperfectly filled), that the pressure on the anterior part of the ball must gradually approximate to that pressure which an absolute vacuum would produce; but this is like his other criticisms. Robins does nowhere assert that this sudden change of resistance happens in the transition of the velocity from 1132 feet to that of 1131 feet 11 inches or the like, but only that it is very sudden and very great. It may be strictly demonstrated, that such a change must happen in a narrow enough limit of velocities to justify the appellation of sudden: a similar fact may be observed in the motion of a solid through water. If it be gradually accelerated, the water will be found nearly to fill up its place, till the velocity arrives at a certain magnitude, corresponding to the immersion of the body in the water; and then the smallest augmentation of its motion immediately produces a void behind it, into which the water

rushes in a violent manner and is dashed into froth. A gentleman, who has had many opportunities for such observations, assures us, that when standing near the line of direction of a cannon discharging a ball with a large allotment of powder, so that the initial velocity certainly exceeded 1100 feet per second, he always observed a very sudden diminution of the noise which the bullet made during its passage. Although the ball was coming towards him, and therefore its noise, if equable, would be continually increasing, he observed that it was loudest at first. That this continued for a second or two, and suddenly diminished, changing to a sound which was not only weaker, but differed in kind, and gradually increased as the bullet approached him. He said, that the first noise was like the hissing of red-hot iron in water, and that the subsequent noise rather resembled a hazy whistling. Such a change of sound is a necessary consequence of the different agitation of the air in the two cases. We know also, that air rushing into a void, as when we break an exhausted bottle, makes a report like a musket.

Mr Robins's assertion therefore has every argument for its truth that the nature of the thing will admit. But we are not left to this vague reasoning: his experiments show us this diminution of resistance. It clearly appears from them, that in a velocity of 1700 feet the resistance is more than three times the resistance determined by the theory which he supposes the common one. When the velocity was 1065 feet, the actual resistance was $\frac{1}{2}$ of the theoretical; and when the velocity was 400 feet, the actual resistance was about $\frac{1}{4}$ of the theoretical. That he assumed a theory of resistance which gave them all too small, is of no consequence in the present argument.

Mr Robins, in summing up the results of his observations on this subject, gives a rule very easily remembered for computing the resistances to those very rapid motions. It has been already mentioned in the article, GUNNERY, but we repeat it here, in order to accommodate it to the quantities which have been determined in some degree by experiment.

A C B D

Let AB represent the velocity of 1700 feet per second, and AC any other velocity. Make BD to AD as the resistance given by the ordinary theory to the resistance actually observed in the velocity 1700: then will CD be to AD as the resistance assigned by the ordinary theory to the velocity AC is to that which really corresponds to it.

To accommodate this to experiment, recollect* that a sphere of the size of a 12 pound iron shot, moving 25 feet in a second, had a resistance of $\frac{1}{11}$ of a pound. Augment this in the ratio of 25^2 to 1700^2 , and we obtain 210 nearly for the theoretical resistance to this velocity; but by comparing its diameter of $4\frac{1}{2}$ inches with $\frac{1}{2}$, the diameter of the leaden ball, which had a resistance of at least 11 pounds with this velocity, we conclude that the 12 pound shot would have had a resistance of 396 pounds: therefore BD : AD = 210 : 396, and AB : AD = 186 : 396; and AB being 1700, AD will be 3613.

Let AD = a, AC = x, and let R be the resistance to a 12 pound iron shot moving one foot per second, and r the resistance (in pounds) wanted for the velocity x;

A Resist
of A
Gun

Rob
com
resist
and
rap

Fig. 1.

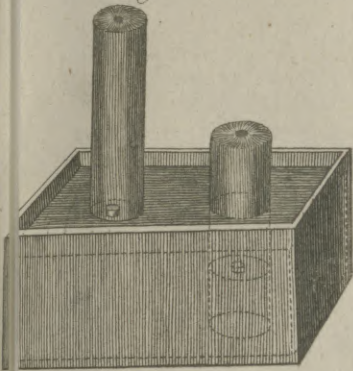


Fig. 3.

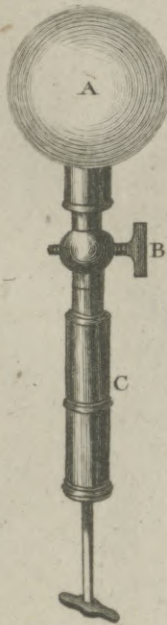


Fig. 4.

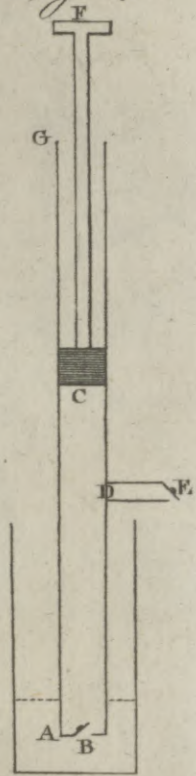


Fig. 2.

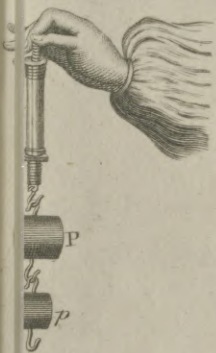


Fig. 7.

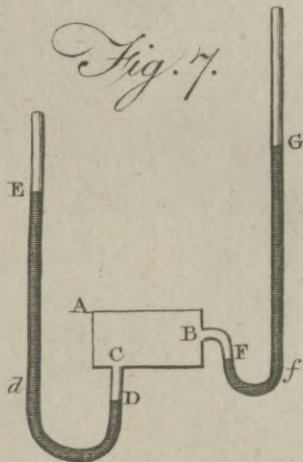


Fig. 5.

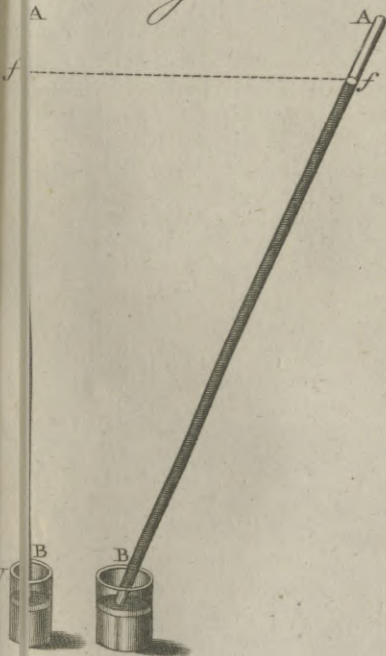


Fig. 8.

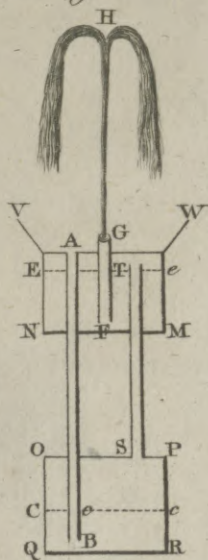


Fig. 9.

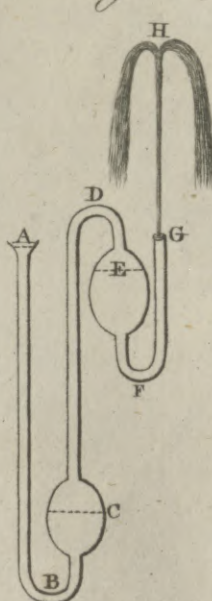


Fig. 6.

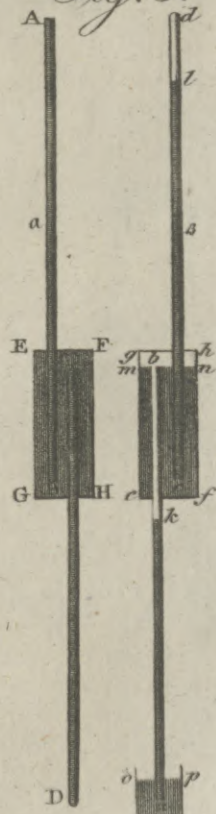


Fig. 11.

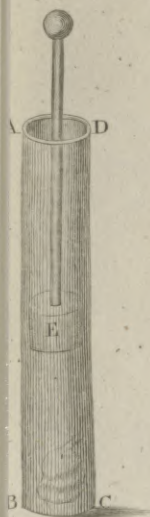


Fig. 10.

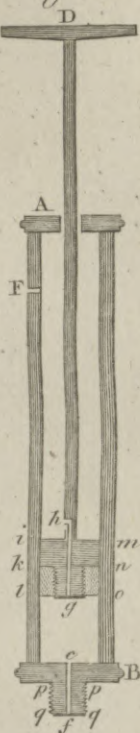


Fig. 16.

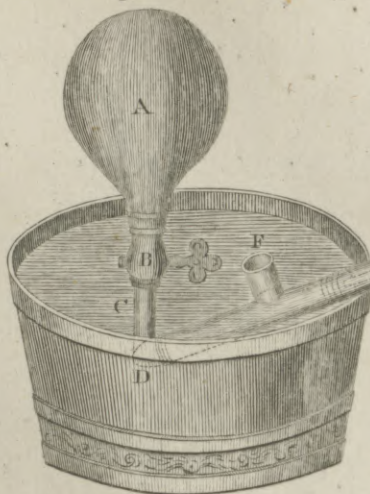


Fig. 17.

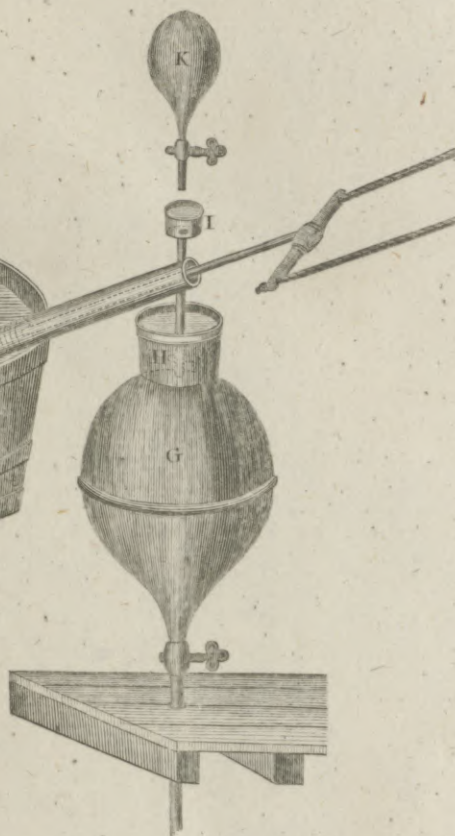


Fig. 12.

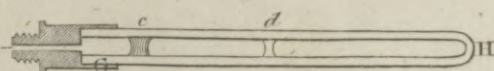
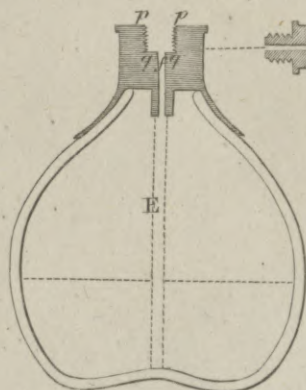
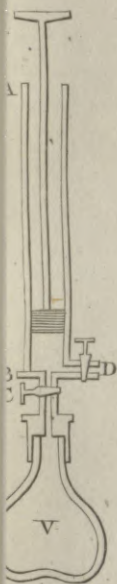


Fig. 13.

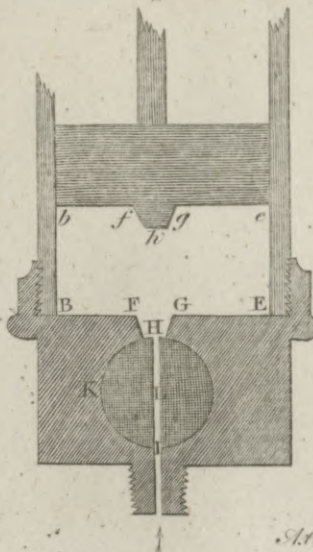


Fig. 15.

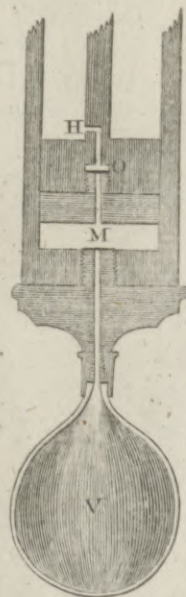


Fig. 14.

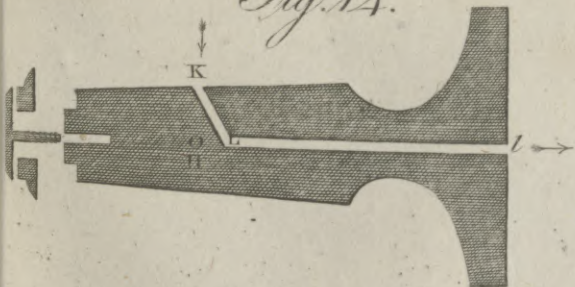




Fig. 18.

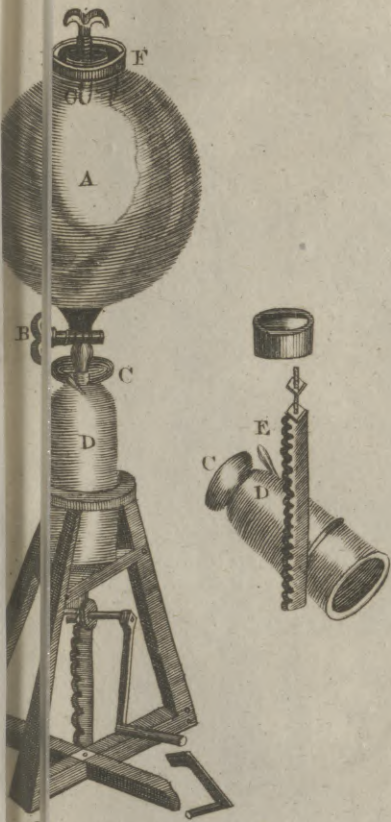


Fig. 19.

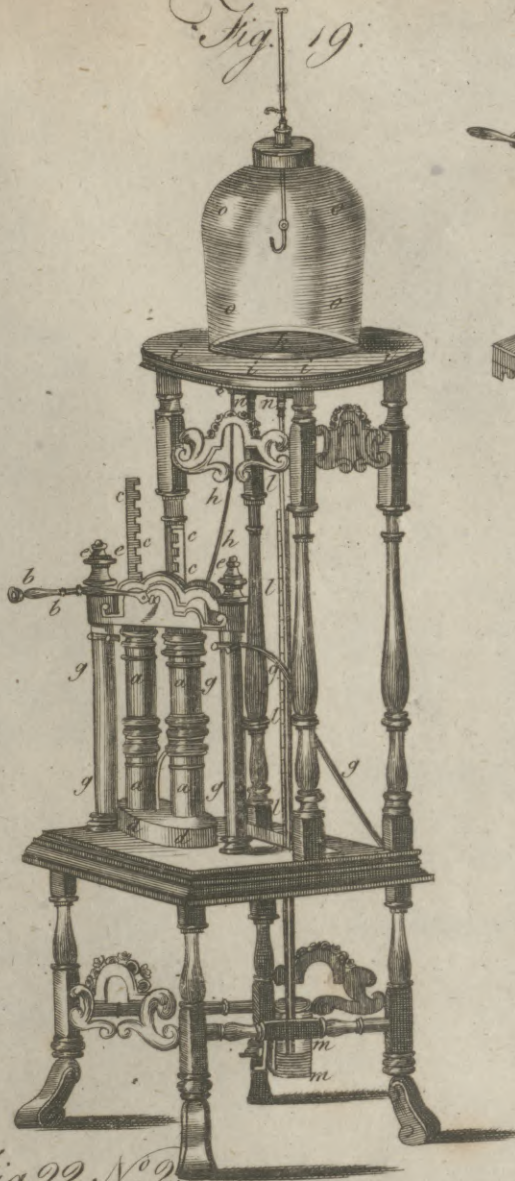


Fig. 20. N^o 1.

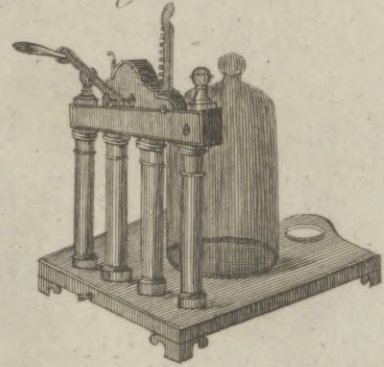


Fig. 20. N^o 2.



Fig. 22. N^o 1.

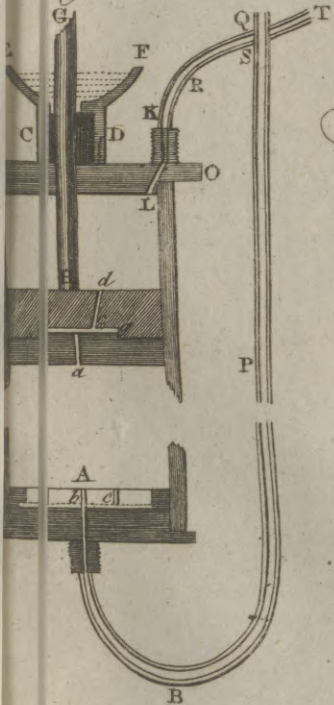


Fig. 22. N^o 2.



Fig. 22. N^o 3.

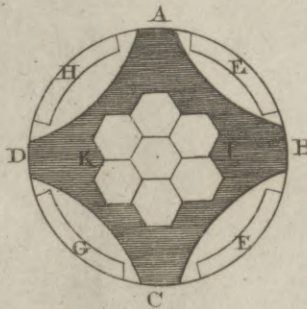


Fig. 21.



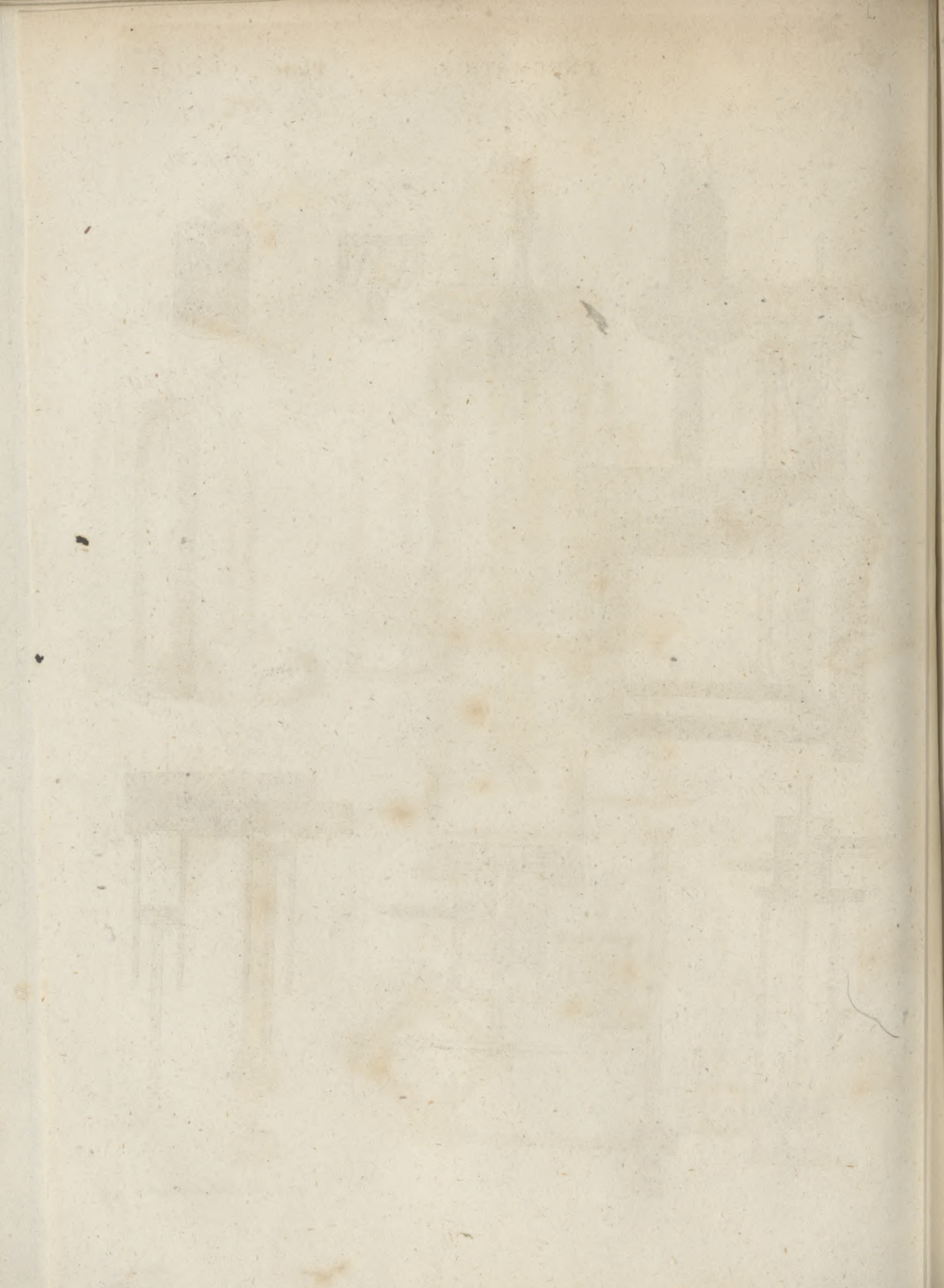


Fig. 23.

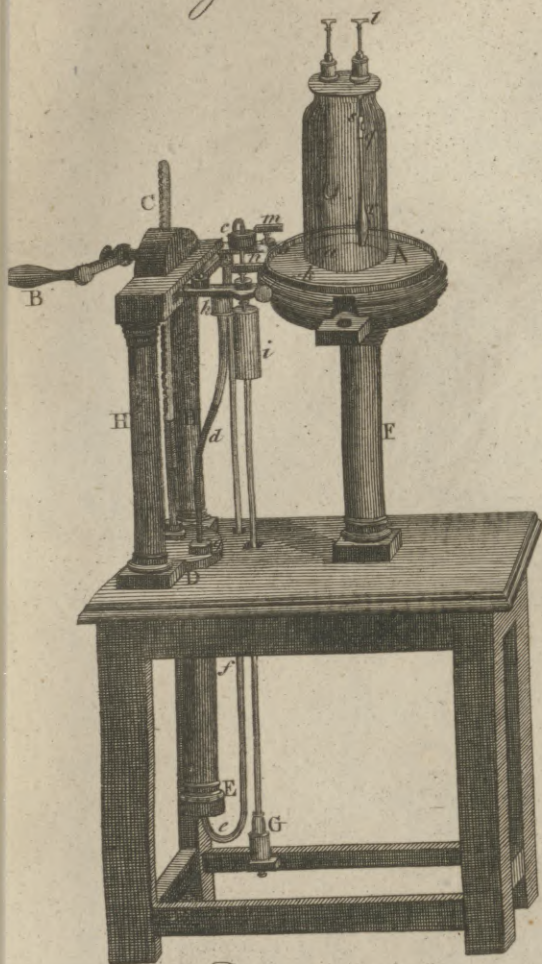


Fig. 24.



Fig. 30.



Fig. 31.



Fig. 29.



Fig. 27.

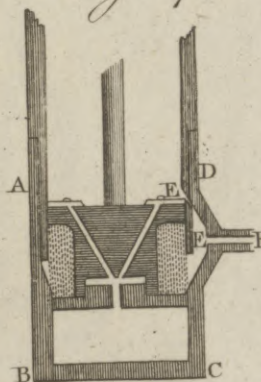


Fig. 26.

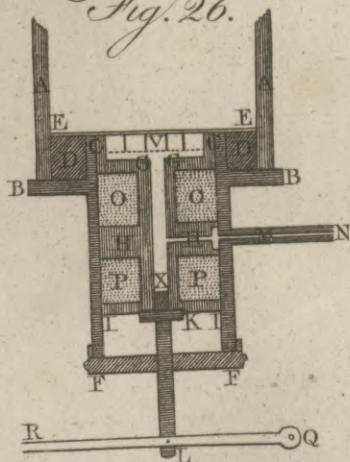


Fig. 28.

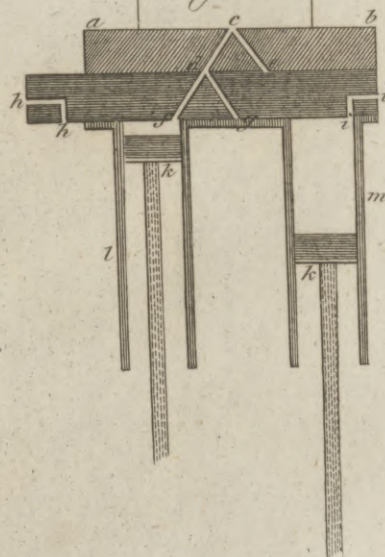
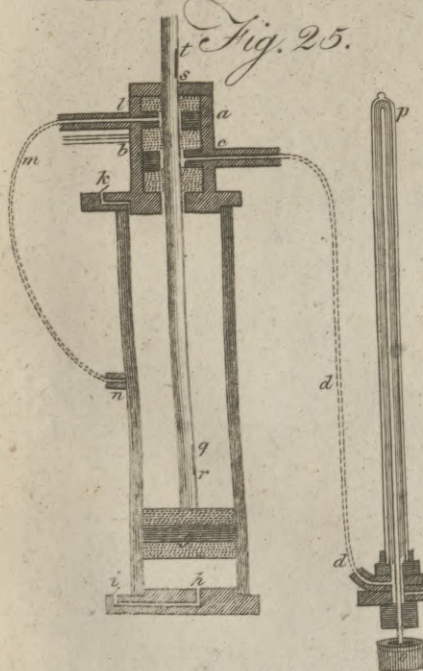


Fig. 25.



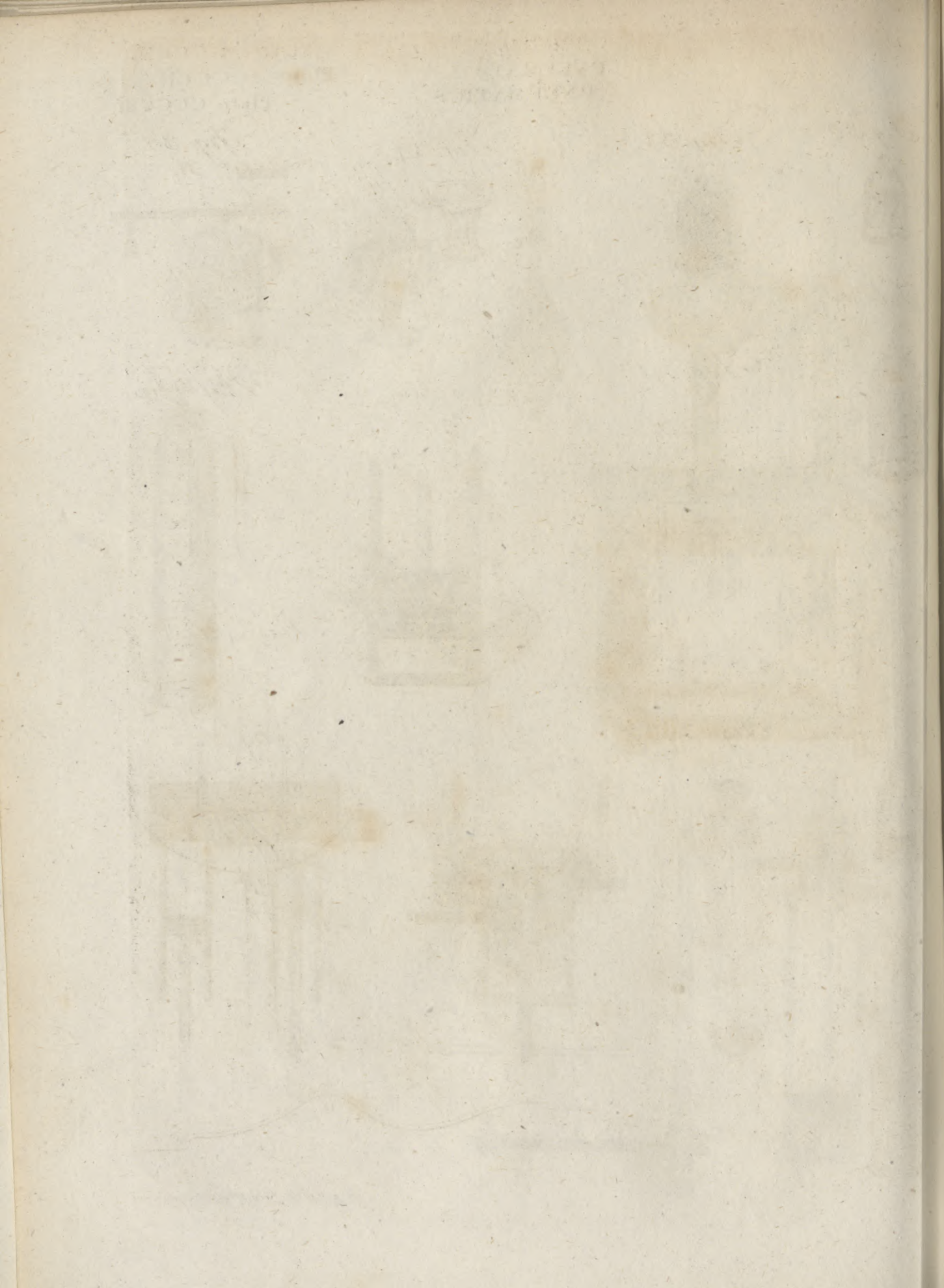


Fig. 32.



Fig. 33.



Fig. 34.



Fig. 35.

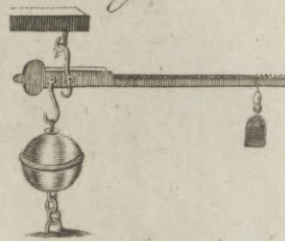


Fig. 36.



Fig. 40.

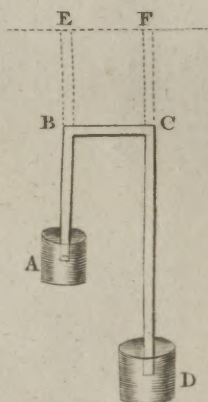


Fig. 42. N° 1.

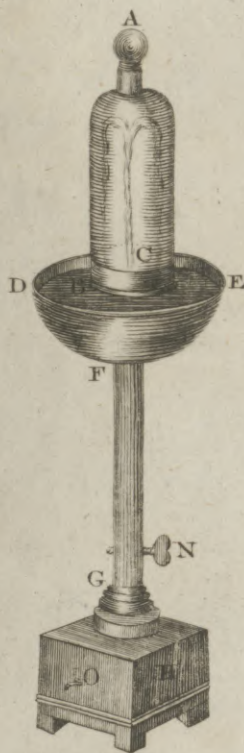


Fig. 41.

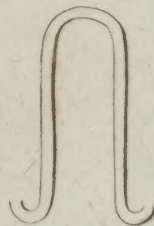


Fig. 38.



Fig. 42. N° 2.

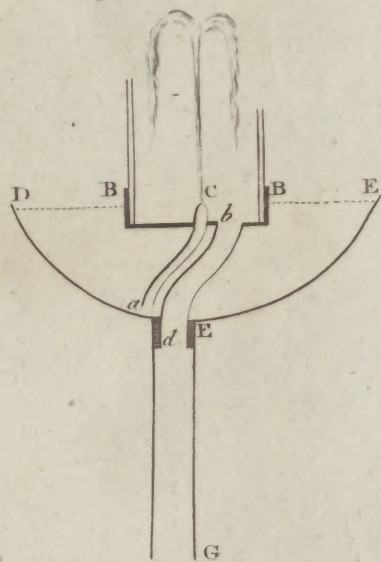


Fig. 37.

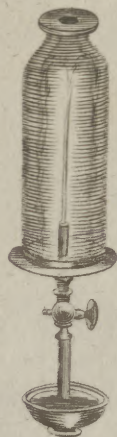
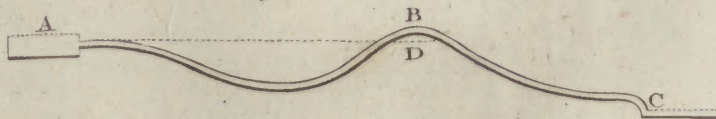


Fig. 39.



Fig. 43.



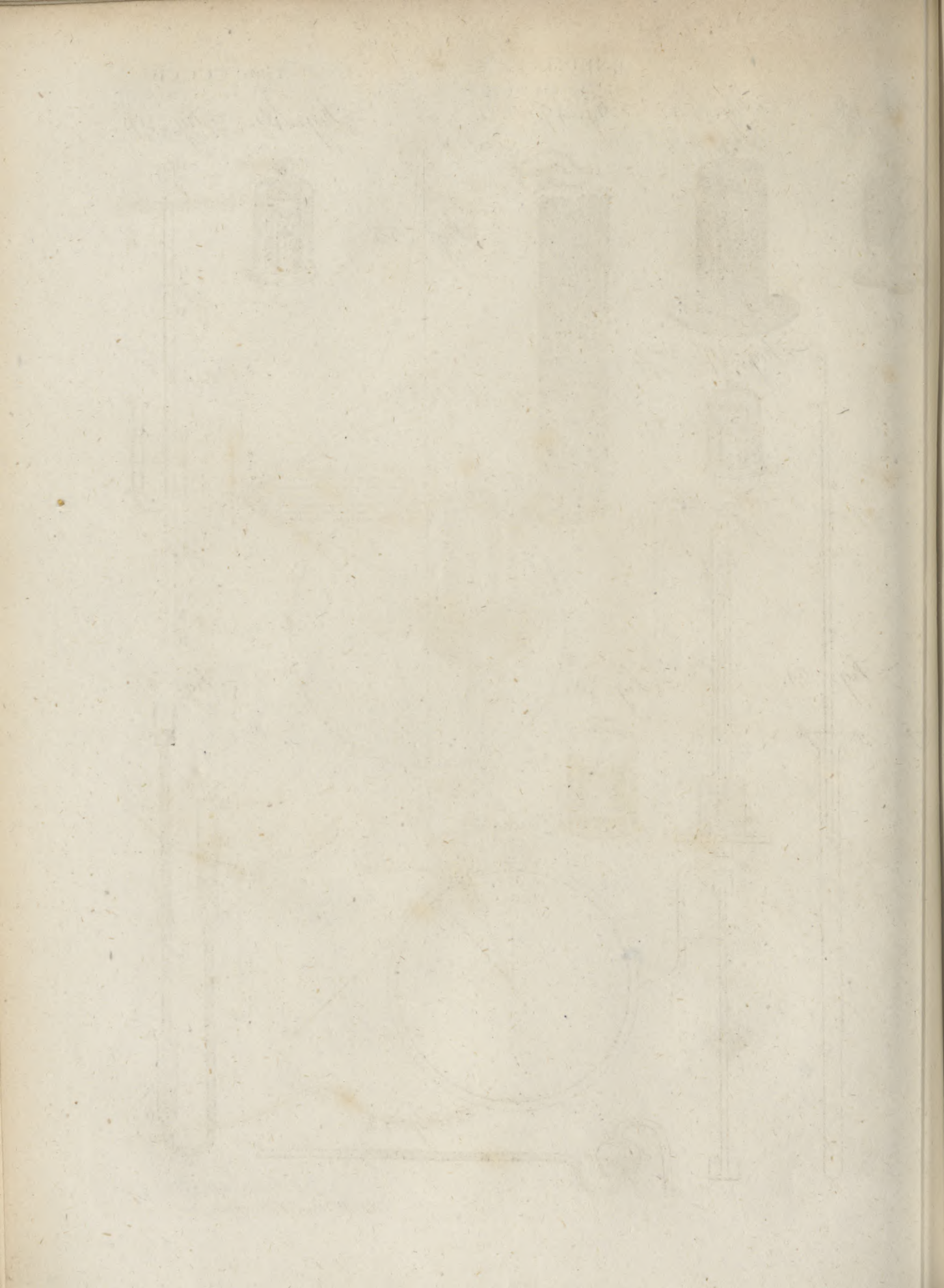


Fig. 45.



Fig. 44.



Fig. 47. N^o 1.



Fig. 46.



Fig. 49.



Fig. 50.

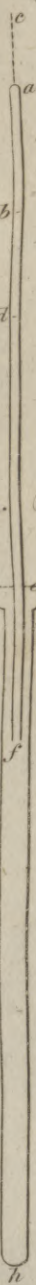


Fig. 47. N^o 2.



Fig. 52.

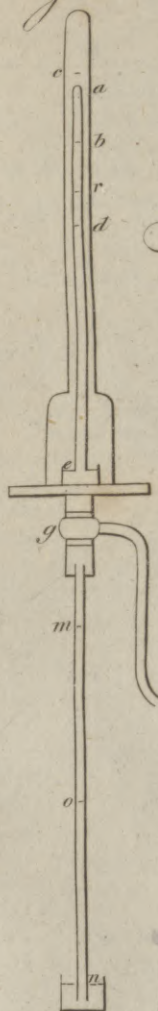


Fig. 51.

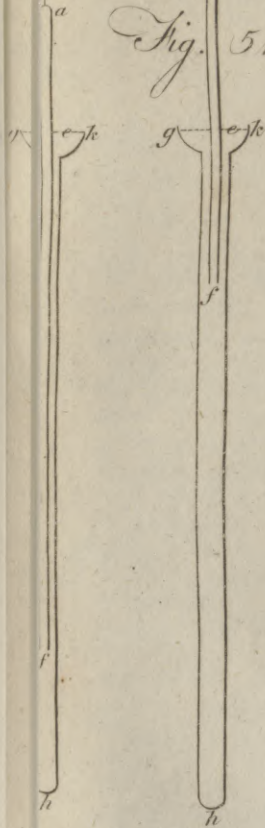


Fig. 48.

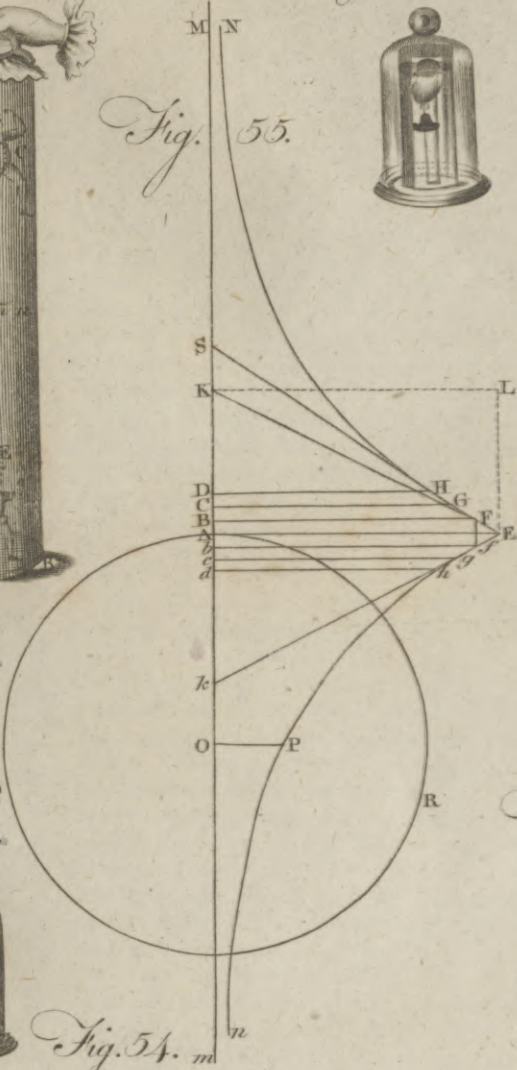


Fig. 54.

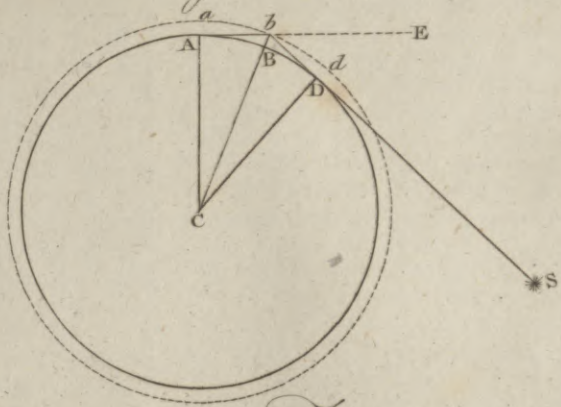


Fig. 56.

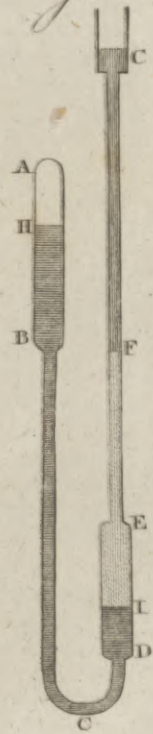
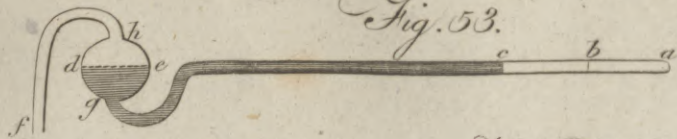
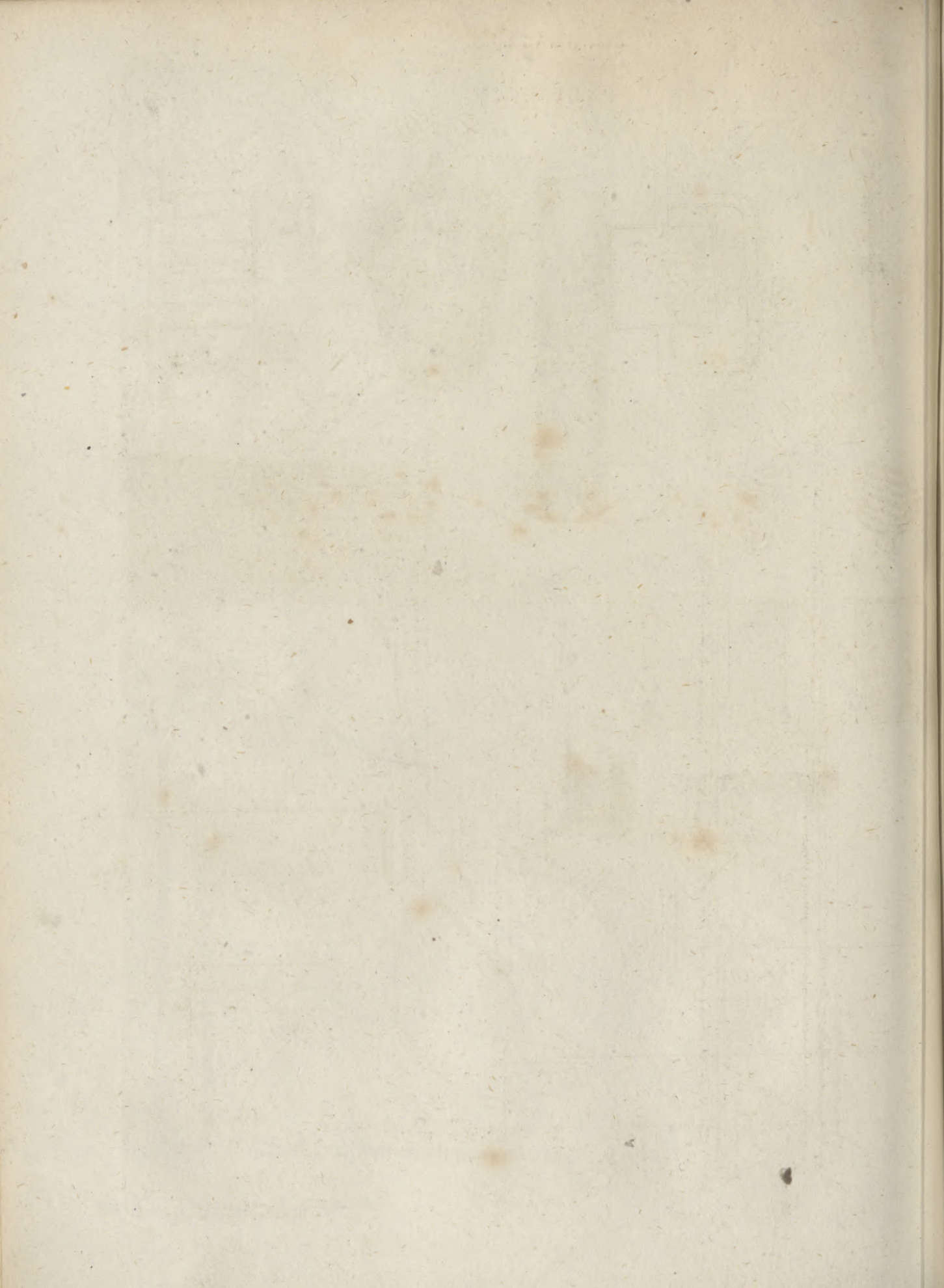


Fig. 53.





the undulation of air. we have $r = R \frac{ax^2}{a-x}$. Mr Robins's experiments give

$R = \frac{1}{13750}$ very nearly. This gives $Ra = 0,263235$,

which is nearly one-fourth. Thus our formula becomes

$r = \frac{0,263235 x^2}{3613-x}$, or very nearly $\frac{x^2}{4(3613-x)}$, falling

short of the truth about $\frac{1}{10}$ th part. The simplicity of the formula recommends it to our use, and when we increase its result $\frac{1}{10}$, it is incomparably nearer to the true result of the theory as corrected by Mr Robins than we can hope that the theory is to the actual resistance. We can easily see that Mr Robins's correction is only a sagacious approximation. If we suppose the velocity 3613 feet, a very possible thing, the resistance by this formula is infinite, which cannot be. We may even suppose that the resistance given by the formula is near the truth only in such velocities as do not greatly exceed 1700 feet per second. No military projectile exceeds 2200, and it is great folly to make it so great, because it is reduced to 1700 almost in an instant, by the enormous resistance.

The resistance to other balls will be made by taking them in the duplicate ratio of the diameters.

It has been already observed, that the first mathematicians of Europe have lately employed themselves in improving this theory of the motion of bodies in a resisting medium; but their discussions are such as few artillerymen can understand. The problem can only be solved by approximation, and this by the quadrature of very complicated curves. They have not been able therefore to deduce from them any practical rules of easy application, and have been obliged to compute tables suited to different cases. Of these performances, that of the Chevalier Borda, in the Memoirs of the Academy of Sciences in 1769, seems the best adapted to military readers, and the tables are undoubtedly of considerable use; but it is not too much to say, that the simple rules of Mr Robins are of as much service, and are more easily remembered: besides, it must be observed, that the nature of military service does not give room for the application of any very precise rule. The only advantage that we can derive from a perfect theory would be an improvement in the construction of pieces of ordnance, and a more judicious appropriation of certain velocities to certain purposes. The service of a gun or mortar must always be regulated by the eye.

There is another motion of which air and other elastic fluids are susceptible, viz. an internal vibration of their particles, or undulation, by which any extended portion of air is distributed into alternate parcels of condensed and rarefied air, which are continually changing their condition without changing their places. By this change the condensation which is produced in one part of the air is gradually transferred along the mass of air to the greatest distances in all directions. It is of importance to have some distinct conception of this motion. It is found to be by this means that distant bodies produce in us the sensation of sound. See SOUND, ACOUSTICS. Sir Isaac Newton treated this subject with his accustomed ingenuity, and has given us a theory of it in the end of the second book of his *Principia*. This theory has been objected to with respect to the conduct of the argument, and other explanations have been given by the most eminent mathematicians. Though they appear to differ from Newton's, their results are precisely the same; but, on a close exami-

nation, they differ no more than John Bernoulli's theorem of centripetal forces differs from Newton's, viz. the one being expressed by geometry and the other by literal analysis. The celebrated De la Grange reduces Newton's investigation to a tautological proposition or identical equation; but Mr Young of Trinity College, Dublin, has, by a different turn of expression, freed Newton's method from this objection. We shall not repeat it here, but refer our mathematical readers to the article ACOUSTICS, it not being our business at present to consider its connection with sound. This will make the subject of a distinct article.

But since Newton published this theory of aerial undulations, and of their propagation along the air, and since the theory has been so corrected and improved to be received by the most accurate philosophers as a branch of natural philosophy susceptible of rigid demonstration, it has been freely resorted to by many writers on other parts of natural science, who did not profess to be mathematicians, but made use of it for explaining phenomena in their own line on the authority of the mathematicians themselves. Learning from them that this vibration, and the *quaquaversum* propagation of the pulses, were the necessary properties of an elastic fluid, and that the rapidity of this propagation had a certain assignable proportion to the elasticity and density of the fluid, they freely made use of these concessions, and have introduced elastic vibrating fluids into many facts, where others would suspect no such thing, and have attempted to explain by their means many abstruse phenomena of nature. Æthers are everywhere introduced, endued with great elasticity and tenacity. Vibrations and pulses are supposed in this æther, and these are offered as explanations. The doctrines of animal spirits and nervous fluids, and the whole mechanical system of Hartley, by which the operations of the soul are said to be explained, have their foundation in this theory of aerial undulations. If these fancied fluids, and their internal vibrations, really operate in the phenomena ascribed to them, any explanation that can be given of the phenomena from this principle must be nothing else than showing that the legitimate consequences of these undulations are similar to the phenomena; or, if we are no more able to see this last step than in the case of sound (which we know to be one consequence of the aerial undulations, although we cannot tell how), we must be able to point out, as in the case of sound, certain constant relations between the general laws of these undulations and the general laws of the phenomena. It is only in this way that we think ourselves intitled to say that the aerial undulations are causes, though not the only causes, of sound; and it is because there is no such relation, but, on the contrary, a total dissimilarity, to be observed between the laws of elastic undulations and the laws of the propagation of light, that we assert with confidence that ethereal undulations are not the causes of vision.

Explanations of this kind suppose, therefore, in the first place, that the philosopher who proposes them understands precisely the nature of these undulations; in the next place, that he makes his reader sensible of those circumstances of them which are concerned in the effect to be explained; and, in the third place, that he makes the reader understand how this circumstance of the vibrating fluid is connected with the phenomenon, either by showing it to be its mechanical cause,

Undulation of Air.

327
Has been used to explain a variety of natural phenomena.

328
But the application not being made with sufficient precision,

Undulation
of Air

as when the philosopher explains the refounding of a musical chord to a flute or pipe which gave the same tone; or by showing that this circumstance of the undulation always accompanies the phenomenon, as when the philosopher shows that 233 vibrations of air in a second, in whatever manner or by whatever cause they are produced, always are followed by the sensation of the tone C in the middle of the harpsichord.

But here we must observe, that, with the exception of Euler's unsuccessful attempt to explain the optical phenomena by the undulations of ether, we have met with no explanation of natural phenomena, by means of elastic and vibrating fluids, where the author has so much as attempted any one of these three things, so indispensably requisite in a logical explanation. They have talked of vibrations without describing them, or giving the reader the least notion of what kind they are; and in no instance that we can recollect have they showed how such vibrations could have any influence in the phenomenon. Indeed, by not describing with precision the undulations, they were freed from the task of showing them to be mechanical causes of the phenomenon; and when any of them show any analogy between the general laws of elastic undulations and the general laws of the phenomenon, the analogy is so vague, indistinct, or partial, that no person of common prudence would receive it as argument in any case in which he was much interested.

329
Has be-
come the
foundation
of mate-
rialism.

We think it our duty to remonstrate against this slovenly way of writing: we would even hold it up to reprobation. It has been chiefly on this faithless foundation that the blind vanity of men has raised that degrading system of opinions called MATERIALISM, by which the affections and faculties of the soul of man have been resolved into vibrations and pulses of ether.

330
Of the mo-
tion of ela-
stic fluids.

We also think it our duty to give some account of this motion of elastic fluids. It must be such an account as shall be understood by those who are not mathematicians, because those only are in danger of being misled by the improper application of them. Mathematical discussion is, however, unavoidable in a subject purely mathematical; but we shall introduce nothing that may not be easily understood or confided in; and we trust that mathematical readers will excuse us for a mode of reasoning which appears to them lax and inelegant.

331
How they
differ from
inelastic
fluids in
propagat-
ing any
agitation
of their
parts.

The first thing incumbent on us is to show how elastic fluids differ from the unelastic in the propagation of any agitation of their parts. When a long tube is filled with water, and any one part of it pushed out of its place, the whole is instantly moved like a solid mass. But this is not the case with air. If a door be suddenly shut, the window at the farther end of a long and close room will rattle; but some time will elapse between the shutting of the door and the motion of the window. If some light dust be lying on a braced drum, and another be violently beat at a little distance from it, an attentive observer will see the dust dance up from the parchment; but this will be at the instant he hears the sound of the stroke on the other drum, and a sensible time after the stroke. Many such familiar facts show that the agitation is gradually communicated along the air; and therefore that when one particle is agitated by any sensible motion, a finite time, however small, must elapse before the adjoining particle is agitated in the same manner. This would not be the case in water

if water be perfectly incompressible. We think that this Undula of Air may be made intelligible with very little trouble.

A a . . . B b . . . C . . . D . . .

Let A, B, C, D, &c. be a row of aerial particles, at such distances that their elasticity just balances the pressure of the atmosphere; and let us suppose (as is deducible from the observed density of air being proportional to the compressing force) that the elasticity of the particles, by which they keep each other at a distance, is as their distances inversely. Let us farther suppose that the particle A has been carried, with an uniform motion, to *a* by some external force. It is evident that B cannot remain in its present state; for being now nearer to *a* than to C, it is propelled towards C by the excess of the elasticity of A above the natural elasticity of C. Let E be the natural elasticity of the particles, or the force corresponding to the distance BC or BA, and let F be the force which impels B towards C, and let *f* be the force exerted by A when at *a*. We have

$$\begin{aligned} E &: f = Ba : BC, = Ba : BA; \\ \text{and } E : f - E &= Ba : BA - Ba = Ba : Aa; \\ \text{or } E : F &= Ba : Aa. \end{aligned}$$

Now in fig. 71. let ABC be the line joining three particles, to which draw FG, PH parallel, and IAF, HBG perpendicular. Take IF or HG to represent the elasticity corresponding to the distance AB. Let the particle A be supposed to have been carried with an uniform motion to *a* by some external force, and draw R_aM perpendicular to RG, and make FI : RM = Ba : BA. We shall then have FI : PM = Ba : Aa; and PM will represent the force with which the particle B is urged towards C. Suppose this construction to be made for every point of the line AB, and that a point M is thus determined for each of them, mathematicians know that all these points M lie in the curve of a hyperbola, of which FG and GH are the asymptotes. It is also known by the elements of mechanics, that since the motion of A along AB is uniform, Aa or IP may be taken to represent the time of describing Aa; and that the area IPM represents the whole velocity which B has acquired in its motion towards C when A has come to *a*, the force urging B being always as the portion PM of the ordinate.

Take GX of any length in HG produced, and let GX represent the velocity which the uniform action of the natural elasticity IF could communicate to the particle B during the time that A would uniformly describe AB. Make GX to GY as the rectangle IFGH to the hyperbolic space IFRM, and draw YS cutting MR produced in S, and draw FX cutting MR in T. It is known to the mathematicians that the point S is in a curve line FS, called the logarithmic curve; of which the leading property is, that any line RS parallel to GX is to GX as the rectangle IFGH is to the hyperbolic space IFRM, and that FX touches the curve in F.

This being the case, it is plain, that because RT increases in the same proportion with FR, or with the rectangle IFRP, and RS increases in the proportion of the space IFRM, TS increases in the proportion of the space IPM. Therefore TS is proportional to the velocity of B when A has reached *a*, and RT is pro-

Undulation proportional to the velocity which the uniform action of the natural elasticity would communicate to B in the same time. Then since FT is as the time, and TS is as the velocity, the area FTS will be as the space described by B (urged by the variable force PM); while A, urged by the external force, describes Aa; and the triangle FRT will represent the space which the uniform action of the natural elasticity would cause B to describe in the same time.

And thus it is plain that these three motions can be compared together: the uniform motion of the agitated particle A, the uniformly accelerated motion which the natural elasticity would communicate to B by its constant action, and the motion produced in B by the agitation of A. But this comparison, requiring the quadrature of the hyperbola and logarithmic curve, would lead us into most intricate and tedious computations. Of these we need only give the result, and make some other comparisons which are palpable.

Let Aa be supposed indefinitely small in comparison of AB. The space described by A is therefore indefinitely small; but in this case we know that the ratio of the space FRT to the rectangle IFRP is indefinitely small. There is therefore no comparison between the agitation of A by the external force, and the agitation which natural elasticity would produce on a single particle in the same time, the last being incomparably smaller than the first. And this space FRT is incomparably greater than FTS; and therefore the space which B would describe by the uniform action of the natural elasticity is incomparably greater than what it would describe in consequence of the agitation of A.

From this reasoning we see evidently that A must be sensibly moved, or a finite or measurable time must elapse before B acquires a measurable motion. In like manner B must move during a measurable time before C acquires a measurable motion, &c.; and therefore the agitation of A is communicated to the distant particles in gradual succession.

By a farther comparison of these spaces we learn the time in which each succeeding particle acquires the very agitation of A. If the particles B and C only are considered, and the motion of C neglected, it will be found that B has acquired the motion of A a little before it has described $\frac{1}{2}$ of the space described by A; but if the motion of C be considered, the acceleration of B must be increased by the retreat of C, and B must describe a greater space in proportion to that described by A. By computation it appears, that when both B and C have acquired the velocity of A, B has described nearly $\frac{1}{2}$ of A's motion, and C more nearly $\frac{1}{3}$. Extending this to D, we shall find that D has described still more nearly $\frac{1}{4}$ of A's motion. And from the nature of the computation it appears that this approximation goes on rapidly: therefore, supposing it accurate from the very first particle, it follows from the equable motion of A, that each succeeding particle moves through an equal space in acquiring the motion of A.

The conclusion which we must draw from all this is, that when the agitation of A has been fully communicated to a particle at a sensible distance, the intervening particles, all moving forward with a common velocity, are equally compressed as to sense, except a very few of the first particles; and that this communication, or this propagation of the original agitation, goes on with an uniform velocity.

These computations need not be attended to by such as do not wish for an accurate knowledge of the precise agitation of each particle. It is enough for such readers to see clearly that time *must* elapse between the agitation of A and that of a distant particle; and this is abundantly manifest from the incomparability (excuse the term) of the nascent rectangle IFRP with the nascent triangle FRT, and the incomparability of FRT with FTS.

What has now been shown of the communication of any sensible motion Aa must hold equally with respect to any change of this motion. Therefore if a tremulous motion of a body, such as a spring or bell, should agitate the adjoining particle A by pushing it forward in the direction AB, and then allowing it to come back again in the direction BA, an agitation similar to this will take place in all the particles of the row one after the other. Now if this body vibrate according to the law of motion of a pendulum vibrating in a cycloid, the neighbouring particle of air *will of necessity* vibrate in the same manner; and then Newton's demonstration in art. Acoustics needs no apology. Its only deficiency was, that it *seemed* to prove that this *would be* the way in which every particle would of necessity vibrate; which is not true, for the successive parcels of air will be differently agitated according to the original agitation. Newton only wants to prove the uniform propagation of the agitations, and he selects that form which renders the proof easiest. He proves, in the most unexceptionable manner, that if the particles of a pulse of air are really moving like a cycloidal pendulum, the forces acting on each particle, in consequence of the compression and dilatation of the different parts of the pulse, are precisely such as are necessary for continuing this motion, and therefore no other forces are required. Then since each particle is in a certain part of its path, is moving in a certain direction, and with a certain velocity, and urged by a determined force, it *must* move in that very manner. The objection started by John Bernouilli against Newton's demonstration (in a single line) of the elliptical motion of a body urged by a force in the inverse duplicate ratio of the distance from the focus, is precisely the same with the objection against Newton's demonstration of the progress of aerial undulations, and is equally futile.

It must, however, be observed, that Newton's demonstration proceeds on the supposition that the linear agitations of a particle are incomparably smaller than the extent of an undulation. This is not strictly the case in any instance, and in many it is far from being true. In a pretty strong twang of a harpsichord wire, the agitation of a particle may be near the 50th part of the extent of the undulation. This must disturb the regularity of the motion, and cause the agitations in the remote undulations to differ from those in the first pulse. In the explosion of a cannon, the breaking of an exhausted bottle, and many instances which may be given, the agitations are still greater. The commentators on Newton's *Principia*, Le Sueur and Jacquier, have shown, and Euler more clearly, that when the original agitations are very violent, the particles of air will acquire a subordinate vibration compounded with the regular cycloidal vibration, and the progress of the pulses will be somewhat more rapid; but the intricacy of the calculus is so great, that they have not been able to determine with any tolerable precision what the change of velocity will be.

Undulation
of Air.

333
It is
strengthened
by compar-
ing the
found of a
cannon
near and at
a distance.

All this, however, is fully confirmed by experiment on sounds. The sound of a cannon at 10 or 20 miles distance does not in the least resemble its sound when near. In this case it is a loud instantaneous crack, to which we can assign no musical pitch: at a distance, it is a grave sound, of which we can tell the note; and it begins softly, swells to its greatest loudness, and then dies away growling. The same may be said of a clap of thunder, which we know to be a loud snap of still less duration. It is highly probable that the appreciable tone which those distant sounds afford are produced by the continuance of these subordinate vibrations which are added together and fortified in the successive pulses, though not perceptible in the first, in a way somewhat resembling the resonance of a musical chord. Newton's explanation gathers evidence therefore from this circumstance. And we must further observe, that all elastic bodies tremble or vibrate almost precisely as a pendulum swinging in a cycloid, unless their vibrations are uncommonly violent; in which case they are quickly reduced to a moderate quantity by the resistance of the air. The only very loud sounds which we can produce in this way are from great bells; and in these the utmost extent of the vibration is very small in comparison with the breadth of the pulse. The velocity of these sounds has not been compared with that of cannon, or perhaps it would be found less, and an objection against Newton's determination removed. He gives 969 feet per second, Experiment 1142.

334
The agitation
in air
probability
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form.

But it is also very probable, that in the propagation through the air, the agitation gradually and rapidly approaches to this regular cycloidal form in the successive pulses, in the same way as we observe that whatever is the form of agitation in the middle of a smooth pond of water, the spreading circles are always of one gentle form without asperities. In like manner, into whatever form we throw a stretched cord by the twang which we give it, it almost immediately makes smooth undulations, keeping itself in the shape of an elongated trochoid. Of this last we can demonstrate the necessity, because the case is simple. In the wave, the investigation is next to impossible; but we see the fact. We may therefore presume it in air. And accordingly we know that any noise, however abrupt and jarring, near at hand, is smooth at a distance. Nothing is more rough and harsh than the scream of a heron; but at half a mile's distance it is soft. The rattle of a drum is also smooth at a distance.

Plate
CCCCVI.

Fig. 72. shows the successive situations of the particles of a row. Each line of the figure shows the same particles marked with the same letters; the first particle *a* being supposed to be removed successively from its quiescent situation and back to it again. The mark \times is put on that part of each line where the agitated particles are at their natural distances, and the air is of the natural density. The mark \cdot is put where the air is most of all compressed, and $:$ where it is most of all dilated; the curve line drawn through the lowest line of the figure is intended to represent the density in every point, by drawing ordinates to it from the straight line: the ordinates below the line indicate a rarity, and those above the line a density, greater than common.

It appears that when *a* has come back to its natural situation, the part of greatest density is between the particles *i* and *k*, and the greatest rarity between *c* and *d*.

We have only to add, that the velocity of this pro-

pagation depends on the elasticity and density of the fluid. If these vary in the same proportion, that is, if the fluid has its elasticity proportional to its density, the velocity will remain the same. If the elasticity or density alone be changed, the velocity of the undulations will change in the direct subduplicate ratio of the elasticity and the inverse subduplicate ratio of the density; for should the elasticity be quadrupled, the quantity of motion produced by it in any given time will be quadrupled. This will be the case if the velocity be doubled; for there would then be double the number of particles doubly agitated. Should the density be quadrupled, the elasticity remaining the same, the quantity of motion must remain the same. This will be the case if the velocity be reduced to one half; for this will propagate half the agitation to half the distance, which will communicate it to twice the number of particles, and the quantity of motion will remain the same. The same may be said of other pro-

portions, and therefore $V = \frac{\sqrt{E}}{\sqrt{D}}$. Therefore a change

in the barometer will not affect the velocity of the undulations in air, but they will be accelerated by heat, which diminishes its density, or increases its elasticity. The velocity of the pulses in inflammable air must be at least thrice as great, because its density is but one-tenth of that of air when the elasticity of both are the same.

Let us now attend a little to the propagation of aerial pulses as they really happen; for this hypothesis of a single row of particles is nowhere to be observed.

Suppose a sphere A, fig. 73. filled with condensed air, and that the vessel which contains it is suddenly annihilated. The air must expand to its natural dimensions, suppose BCD. But it cannot do this without pressing aside the surrounding air. We have seen that in any single row of particles this cannot be at once diffused to a distance, but must produce a condensation in the air adjoining; which will be gradually propagated to a distance. Therefore this sphere BCD of the common density will form round it a shell, bounded by EFG, of condensed air. Suppose that at this instant the inner air BCD becomes solid: The shell of condensed air can expand only outwards. Let it expand till it is of the common density, occupying the shell HIK. This expansion, in like manner, must produce a shell of condensed air without it: at this instant let HIK become solid. The surrounding shell of condensed air can expand only outward, condensing another shell without it. It is plain that this must go on continually, and the central agitation will be gradually propagated to a distance in all directions. But, in this process, it is not the same numerical particles that go to a distance. Those of the original sphere go no further than BCD, those of the next shell go no further than HIK, &c. Farther, the expansion outwards of any particle will be more moderate as the diffusion advances; for the whole motion of each shell cannot exceed the original quantity of motion; and the number of particles in each successive shell increases as the surface, that is, as the square of the distance from the centre: therefore the agitation of the particles will decrease in the same ratio, or will be in the inverse duplicate ratio of the distance from the centre. Each successive shell, therefore, contains the same quantity of motion, and the successive agitations of the particles of any row

33
Further
confir-
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of
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theory
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really

Fig. 57.



Fig. 58.

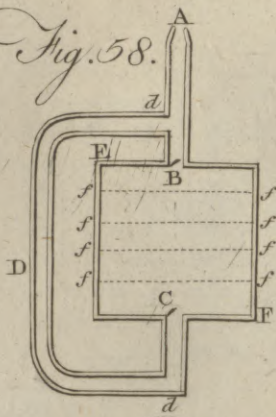


Fig. 61.



Fig. 62.

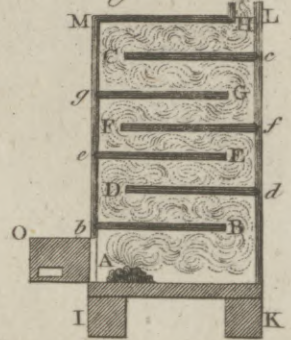


Fig. 59.

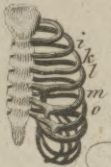


Fig. 60.



Fig. 63.



Fig. 64.

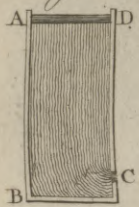


Fig. 65.

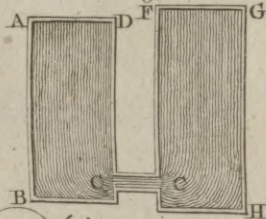


Fig. A.

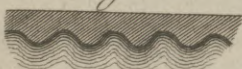


Fig. 70.

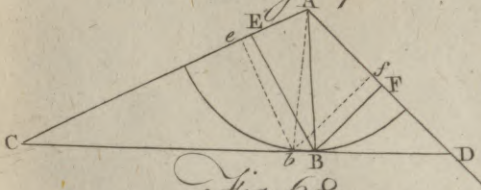


Fig. 68.

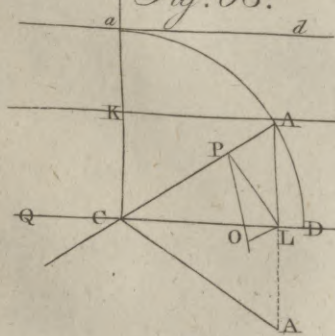


Fig. 69.

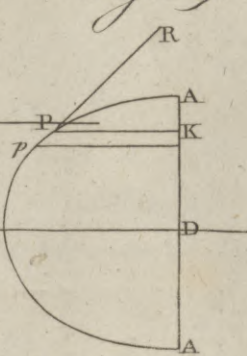


Fig. 66.

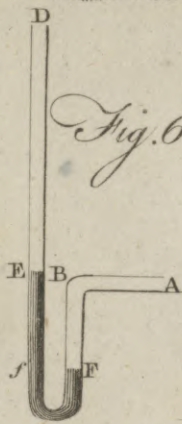


Fig. 67.

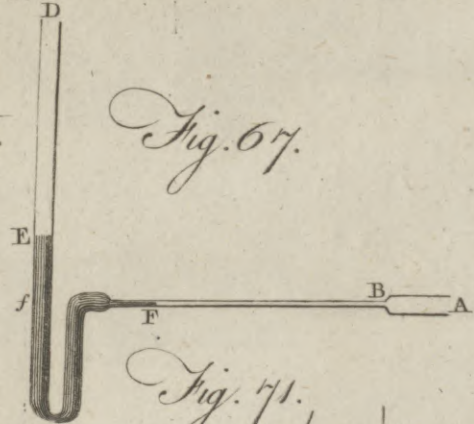


Fig. 71.

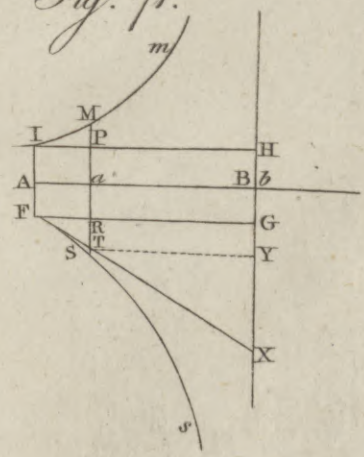


Fig. 72.

Position	A	B	C	D	E	F	G	H	I	K	L	M
2	a	b	c	d	e	f	g	h	i	k	l	m
3	a	b	c	d	e	f	g	h	i	k	l	m
4	a	b	c	d	e	f	g	h	i	k	l	m
5	a	b	c	d	e	f	g	h	i	k	l	m
6	a	b	c	d	e	f	g	h	i	k	l	m
7	a	b	c	d	e	f	g	h	i	k	l	m
8	a	b	c	d	e	f	g	h	i	k	l	m
9	a	b	c	d	e	f	g	h	i	k	l	m
10	a	b	c	d	e	f	g	h	i	k	l	m
11	a	b	c	d	e	f	g	h	i	k	l	m
12	a	b	c	d	e	f	g	h	i	k	l	m

Fig. 73.



Fig. 75.

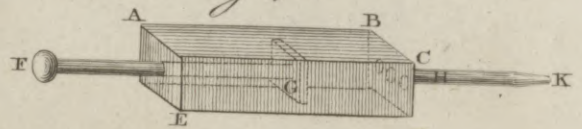


Fig. 74.

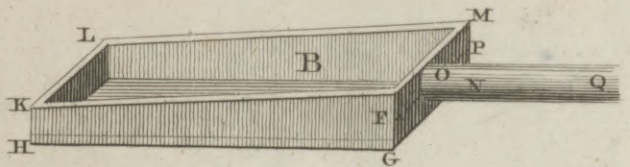
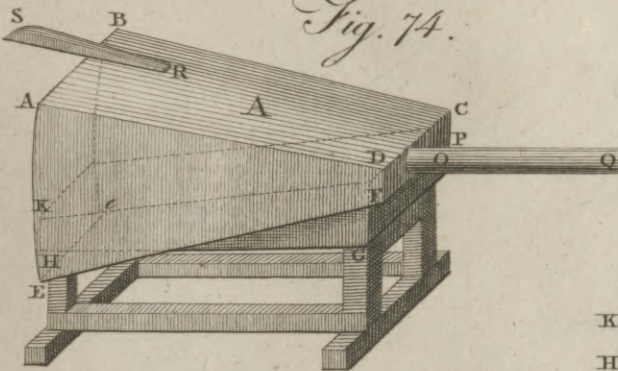
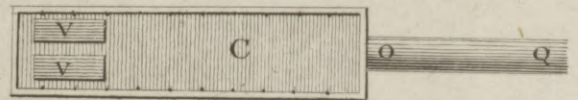
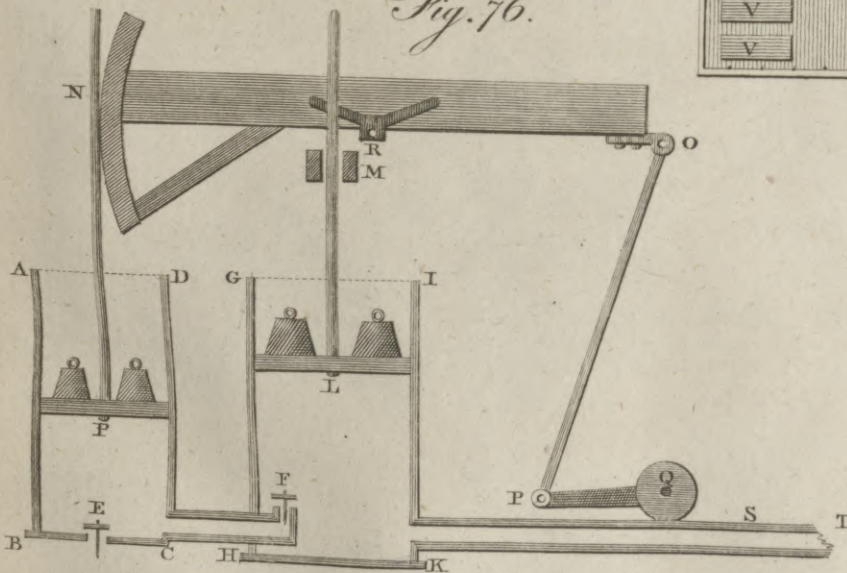
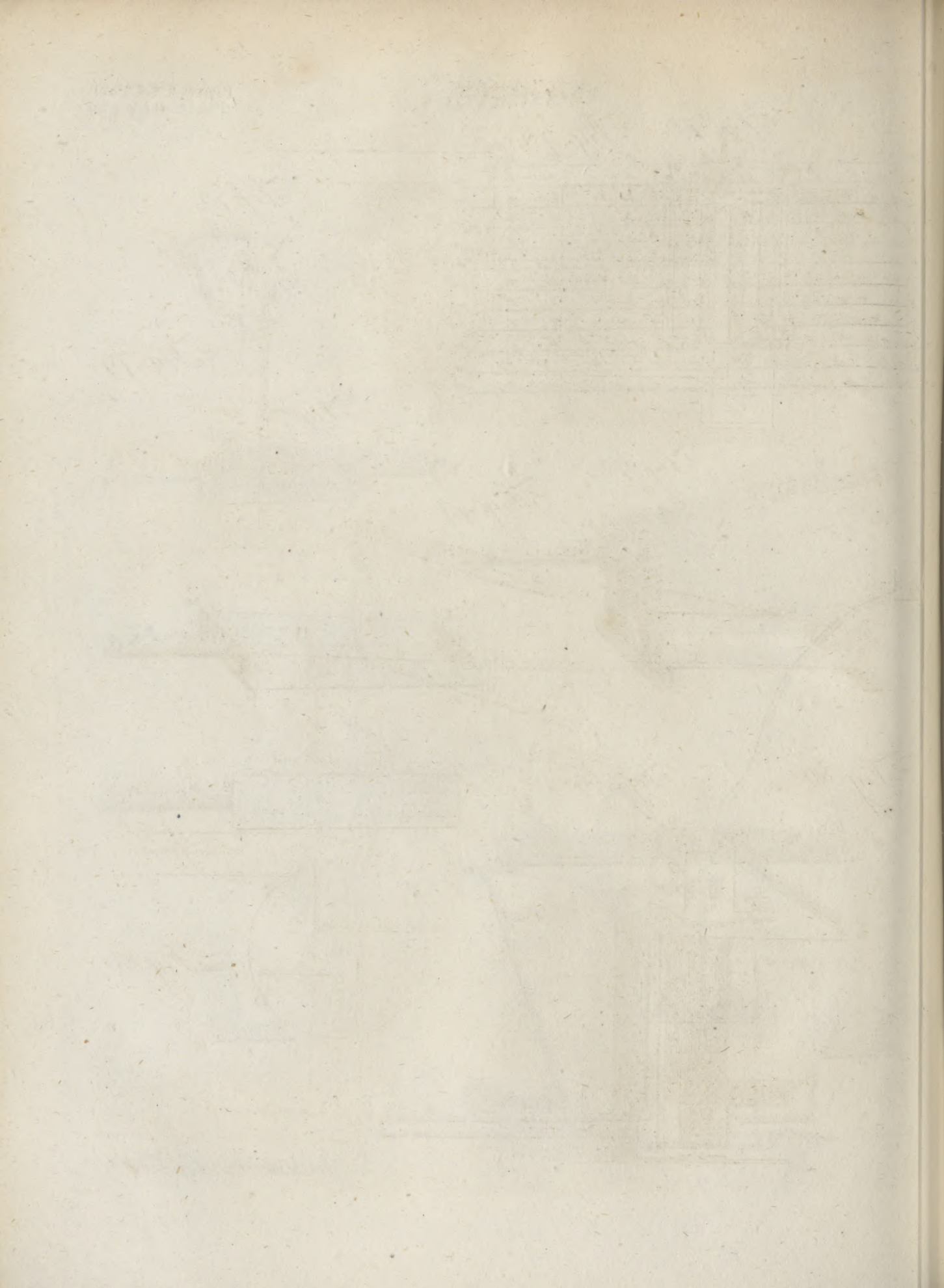
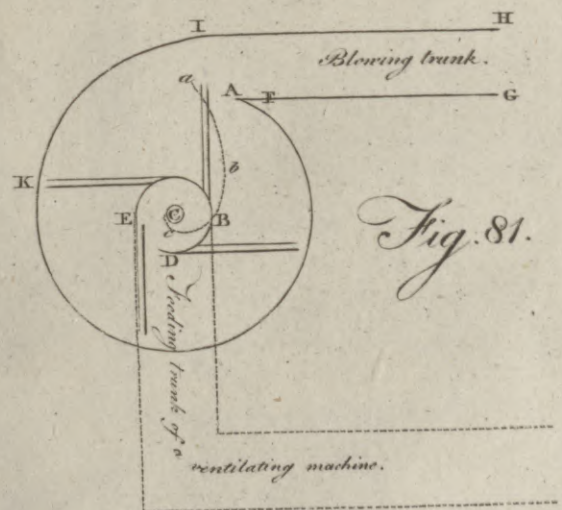
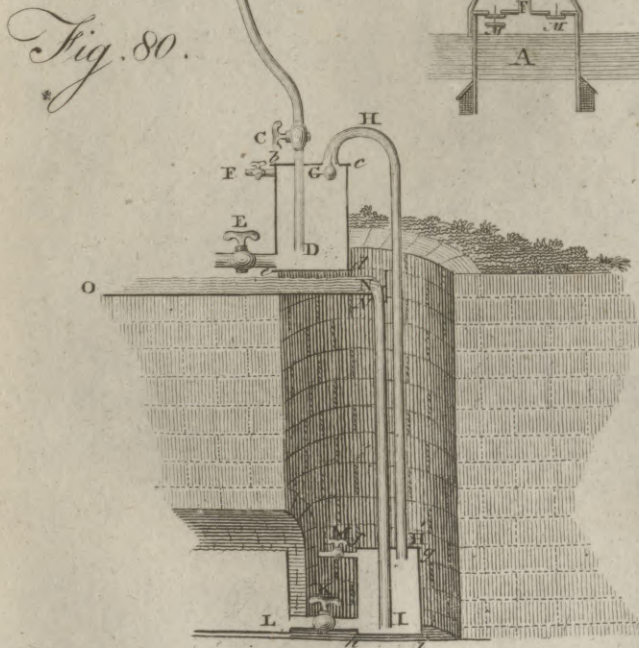
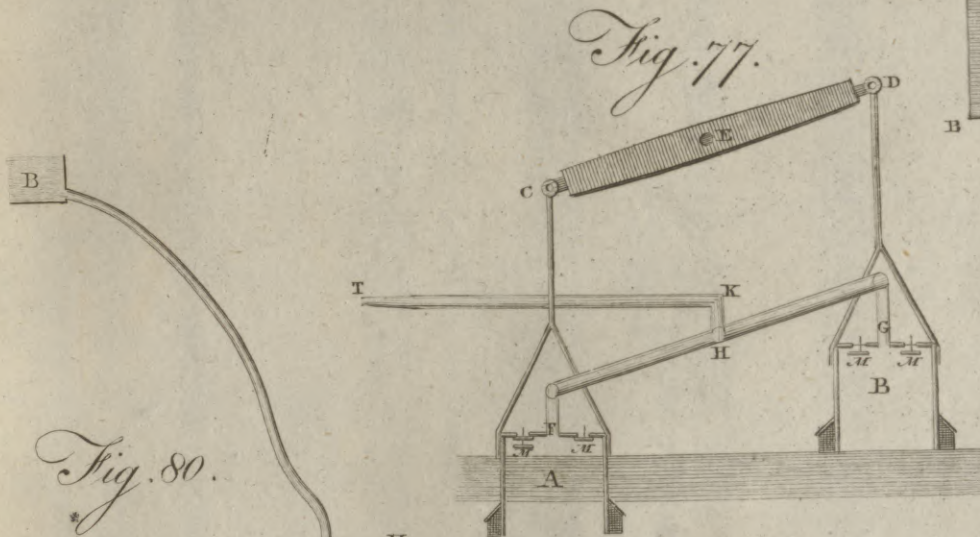
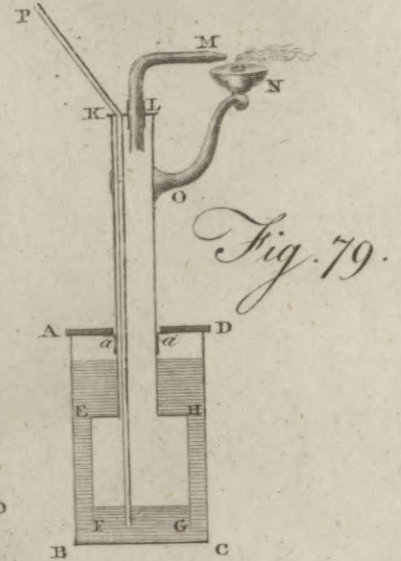
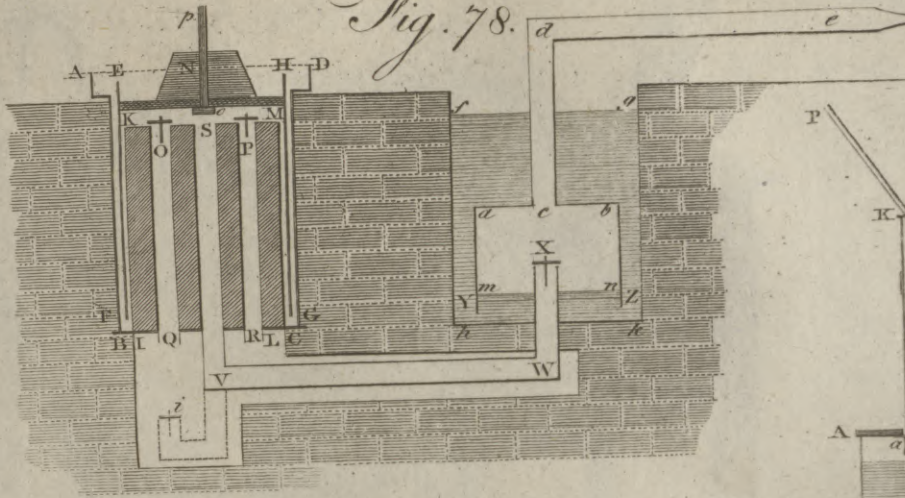


Fig. 76.







Cuthbertson's Air pump.
Fig. 1.

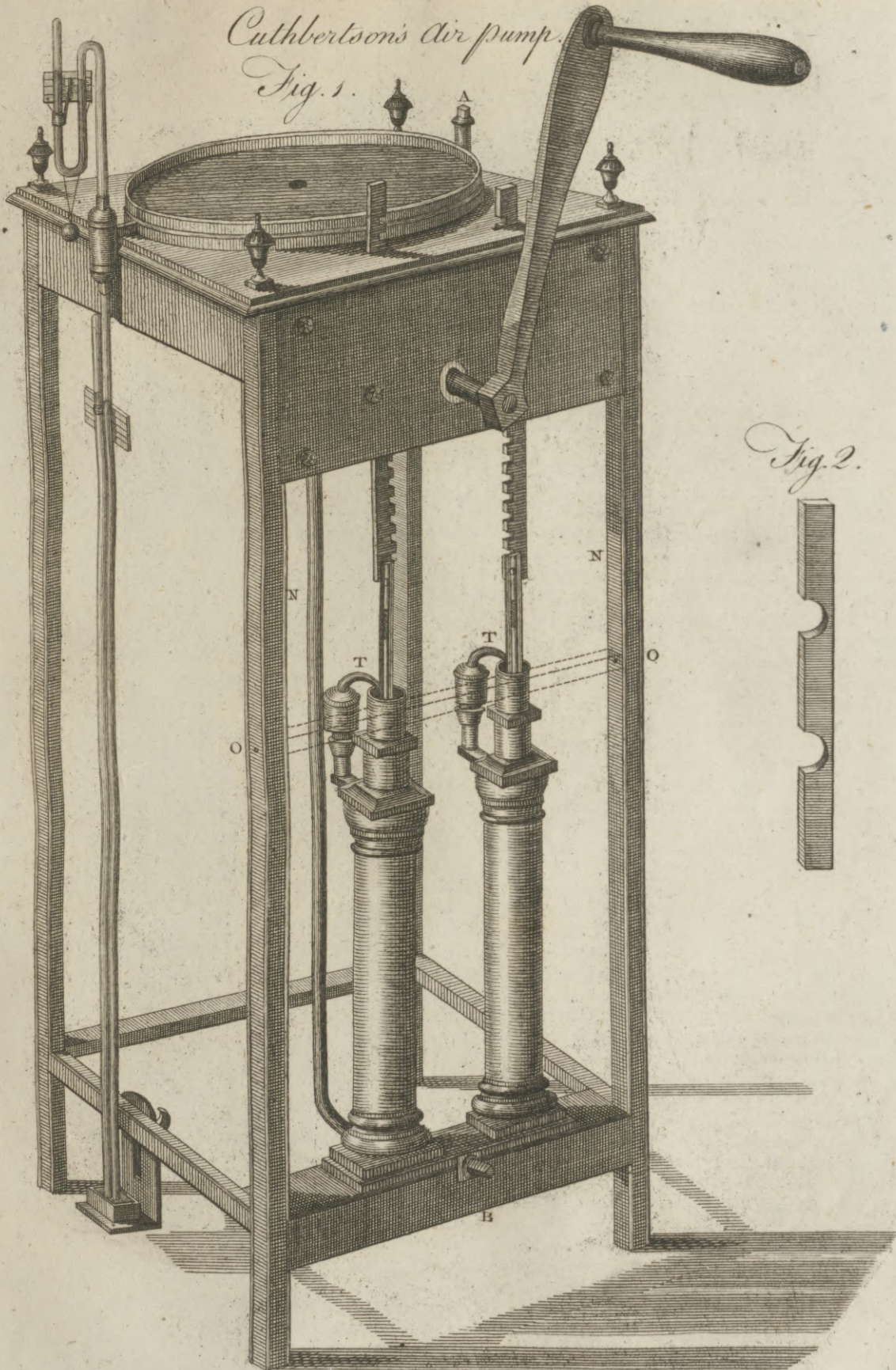


Fig. 2.

Undulation of Air.
 row out from the centre will not be equal to the original agitation, as happens in the solitary row. But this does not affect the velocity of the propagation, because all agitations are propagated equally fast.

We supposed the air A to become solid as soon as it acquired the common density; but this was to facilitate the conception of the diffusion. It does not stop at this bulk; for while it was denser it had a tendency to expand. Therefore each particle has attained this distance with an accelerated motion. It will, therefore, continue this motion like a pendulum that has passed the perpendicular, till it is brought to rest by the air without it; and it is now rarer than common air, and collapses again by the greater elasticity of the air without it. This outward air, therefore, in regaining its natural density, must expand both ways. It expands towards the centre, following the collapsing of the air within it; and it expands outwards, condensing the air beyond it. By expanding inwards, it will again condense the air within it, and this will again expand; a similar motion happens in all the outward shells; and thus there is propagated a succession of condensed and rarefied shells of air, which gradually swell to the greatest distance.

It may be demonstrated, that when the central air has for the second time acquired the natural density, it will be at rest, and be disturbed no more; and that this will happen to all the shells in succession. But the demonstration is much too intricate for this place; we must be contented with pointing out a fact perfectly analogous. When we drop a small pebble into water, we see it produce a series of circular waves, which go along the surface of smooth water to a great distance, becoming more and more gentle as they recede from the centre; and the middle, where the agitation was first produced, remains perfectly smooth, and this smoothness extends continually; that is, each wave when brought to a level remains at rest. Now these waves are produced and propagated by the depression and elevation made at the centre. The elevation tends to diffuse itself; and the force with which each particle of water is actuated is a force acting directly up and down, and is proportional to the elevation or depression of the particle. This hydrostatical pressure operates precisely in the same way as the condensation and rarefaction of the air; and the mathematical investigation of the propagation of the circular undulations on smooth water is similar in every step to that of the propagation of the spherical waves in still air. For this we appeal to Newton's *Principia*, or to Euler's *Opuscula*, where he gives a very beautiful investigation of the velocity of the aerial pulses; and to some memoirs of de la Grange in the collections of the academies of Berlin and Turin. These two last authors have made the investigation as simple as seems possible, and have freed it from every objection which can be stated against the geometrical one of their great teacher Newton.

Having said this much on the similarity between the waves on water and the aerial undulations, we shall have recourse to them, as affording us a very sensible object to represent many affections of the other which it would be extremely difficult to explain. We neither see nor feel the aerial undulations; and they behaved, therefore, to be described very abstractedly and imperfectly. In the watery wave there is no permanent progressive motion of the water from the centre. Throw a small bit of

cork on the surface, and it will be observed to popple up and down without the least motion outwards. In like manner, the particles of air are only agitated a very little outwards and inwards; which motion is communicated to the particles beyond them, while they themselves come to rest, unless agitated afresh; and this agitation of the particles is inconceivably small. Even the explosion of a cannon at no great distance will but gently agitate a feather, giving it a single impulse outwards, and immediately after another inwards or towards the cannon. When a harpsichord wire is forcibly twanged at a few feet distance, the agitation of the air is next to insensible. It is not, however, nothing; and it differs from that in a watery wave by being really outwards and inwards. In consequence of this, when the condensed shell reaches an elastic body, it impels it slightly. If its elasticity be such as to make it acquire the opposite shape at the instant that the next agitation and condensed shell of air touches it, its agitation will be doubled, and a third agitation will increase it, and so on, till it acquire the agitation competent to that of the shell of air which reaches it, and it is thrown into *sensible* vibration, and gives a sound extremely faint indeed, because the agitation which it acquires is that corresponding to a shell of air considerably removed from the original string. Hence it happens that a musical chord, pipe, or bell, will cause another to resound, whose vibrations are isochronous with its own; or if the vibrations of the one coincides with every second, or third, or fourth, &c. of the other; just as we can put a very heavy pendulum into sensible motion by giving it a gentle puff with the breath at every vibration, or at every second, third, or fourth, &c. A drum struck in the neighbourhood of another drum will agitate it *very sensibly*; for here the stroke depresses a very considerable surface, and produces an agitation of a considerable mass of air: it will even agitate the surface of stagnant water. The explosion of a cannon will even break a neighbouring window. The shell of condensed air which comes against the glass has a great surface and a great agitation: the best security in this case is to throw up the sash; this admits the condensed air into the room, which acts on the inside of the window, balancing part of the external impulse.

It is demonstrated in every elementary treatise of natural philosophy, that when a wave on water meets any plane obstacle, it is reflected by it from a centre equally removed behind the obstacle; that waves radiating from the focus of a parabola are reflected in waves perpendicular to its axis; that waves radiating from one focus of an ellipse are made to converge to the other focus, &c. &c. All this may be affirmed of the aerial undulations; that when part of a wave gets through a hole in the obstacle, it becomes the centre of a new series of waves; that waves bend round the extremities of an obstacle: all this happens in the aerial undulations. And lastly, that when the surface of water is thrown into regular undulations by one agitation, another agitation in another place will produce other regular waves, which will cross the former without disturbing them in the smallest degree. The same thing happens in air; and experiments may be made on water which will illustrate in the most perfect manner many other affections of the aerial pulses, which we should otherwise conceive very imperfectly. We would

recom-

Undulation
of Air.

recommend to our curious readers to make some of these experiments in a large vessel of milk. Take a long and narrow plate of lead, which, when set on the bottom of the vessel will reach above the surface of the milk; bend this plate into a parabola, elliptical or other curve. Make the undulations by dropping milk on the focus from a small pipe, which will cause the agitations to succeed with rapidity, and then all that we have said will be most distinctly seen, and the experiment will be very amusing and instructive, especially to the musical reader.

339
Caution to
the sup-
porters of
ethers, ani-
mal spirits,
&c.

We would now request all who make or read explanations of natural phenomena by means of vibrations of ethers, animal spirits, nervous fluids, &c. to fix their attention on the nature of the agitation in one of these undulations. Let him consider whether this can produce the phenomenon, acting as any matter must act, by impulse or by pressure. If he sees that it can produce the phenomenon, he will be able to point out the very motion it will produce, both in quantity and direction, in the same manner as Sir Isaac Newton has pointed out all the irregularities of the moon's motion produced by the disturbing force of the sun. If he cannot do this, he fails in giving the first evidence of a mechanical explanation by the action of an elastic vibrating fluid. Let him then try to point out some palpable connection between the general phenomena of elastic undulations and the phenomenon in question; this would show an accompaniment to have at least some probability. It is thus only we learn that the undulations of air produce sound: we cannot tell how they affect the mechanism of the ear; but we see that the phenomena of sound always accompany them, and that certain modifications of the one are regularly accompanied by certain modifications of the other. If we cannot do this neither, we have derived neither explanation nor illustration from the elastic fluid. And lastly, let him remember that even if he should be able to show the competency of this fluid to the production of the phenomenon, the whole is still an hypothesis, because we do not know that such a fluid exists.

340
The folly
of appeal-
ing to such
unknown
substances.

We will venture to say, that whoever will proceed in this prudent manner will soon see the futility of most of the explanations of this kind which have been given. They are unfit for any but consummate mathematicians; for they alone really understand the mechanism of aerial undulations, and even they speak of them with hesitation as a thing but imperfectly understood. But even the unlearned in this science can see the incompatibility of the hypotheses with many things which they are brought to explain. To take an instance of the conveyance of sensation along the nerves; an elastic fluid is supposed to occupy them, and the undulations of this fluid are thought to be propagated along the nerves. Let us just think a little how the undulations would be conveyed along the surface of a canal which was completely filled up with reeds and bulrushes, or let us make the experiment on such a canal: we may rest assured that the undulations in the one case will resemble those in the other; and we may see that in the canal there will be no regular or sensible propagation of the waves.

Let these observations have their influence, along with others which we have made on other occasions, to wean our readers from this fashionable proneness to in-

roduce invisible fluids and unknown vibrations into our physical discussions. They have done immense, and we fear irreparable, mischief in science; and there is but one phenomenon that has ever received any explanation by their means.

This may suffice for a loose and popular account of aerial undulations; and with it we conclude our account of the motion, impulse, and resistance of air.

We shall now explain a number of natural appearances, depending on its pressure and elasticity, appearances not sufficiently general, or too complicated for the purposes of argument, while we were employed in the investigation of these properties, but too important to be passed over in silence.

It is owing to the pressure of the atmosphere that two surfaces which accurately fit each other cohere with such force. This is a fact familiarly known to the glass-grinders, polishers of marble, &c. A large lens or speculum, ground on its tool till it becomes very smooth, requires more than any man's strength to separate it directly from the tool. If the surface is only a square inch, it will require 15 pounds to separate them perpendicularly, though a very moderate force will make them slide along each other. But this cohesion is not observed unless the surfaces are wetted or smeared with oil or grease; otherwise the air gets between them, and they separate without any trouble. That this cohesion is owing to the atmospheric pressure, is evident from the ease with which the plates may be separated in an exhausted receiver.

To the same cause we must ascribe the very strong adhesion of snails, periwinkles, limpets, and other univalve shells, to the rocks. The animal forms the rim of its shell, so as to fit the shape of the rock to which it intends to cling. It then fills its shell (if not already filled by its own body) with water. In this condition it is evident that we must act with a force equal to 15 pounds for every square inch of touching surface before we can detach it. This may be illustrated by filling a drinking glass to the brim with water; and having covered it with a piece of thin wet leather, whelm it on a table, and then try to pull it straight up; it will require a considerable force. But if we expose a snail adhering to a stone in the exhausted receiver, we shall see it drop off by its own weight. In the same manner do the remora, the polypus, the lamprey, and many other animals, adhere with such firmness. Boys frequently amuse themselves by pulling out large stones from the pavement by means of a circle of stiff wetted leather fastened to a string. It is owing to the same cause that the bivalve shell fishes keep themselves so firmly shut. We think the muscular force of an oyster prodigious, because it requires such force to open it; but if we grind off a bit of the convex shell, so as to make a hole in it, though without hurting the fish in the smallest degree, it opens with great ease, as it does also *in vacuo*.

The pressure of the air, operating in this way contributes much to the cohesion of bodies, where we do not suspect its influence. The tenacity of our mortars and cements would frequently be ineffectual without this assistance.

It is owing to the pressure of the atmosphere that a cask will not run by the cock unless a hole be opened in some other part of the cask. If the cask is not quite full,

Air's Pres-
sure.

341
The air's
pressure oc-
casion the
cohesion of
two sur-
faces accu-
rately fit-
ting each
other;

342
And the adhe-
sion of
snails, &c.
to rocks.

343
Other ef-
fects of
the air's
pressure.

full, some liquor indeed will run out, but it will stop as soon as the diminished elasticity of the air above the liquor is in equilibrio (together with the liquor) with the atmospheric pressure. In like manner, a teapot must have a small hole in its lid to ensure its pouring out the tea. If indeed the hole in the cask is of large dimensions, it will run without any other hole, because air will get in at the upper side of the hole while the liquor runs out by the lower part of it.

On the same principle depends the performance of an instrument used by the spirit dealers for taking out a sample of their spirits. It consists of a long tinplate tube AB (fig. 57.), open atop at A, and ending in a small hole at B. The end B is dipped into the spirits, which rises into the tube; then the thumb is clapt on the mouth A, and the whole is lifted out of the cask. The spirit remains in it till the thumb be taken off; it is then allowed to run into a glass for examination.

It seems principally owing to the pressure of the air that frosts immediately occasion a scantiness of water in our fountains and wells. This is erroneously accounted for, by supposing that the water freezes in the bowels of the earth. But this is a great mistake: the most intense frost of a Siberian winter would not freeze the ground two feet deep; but a very moderate frost will consolidate the whole surface of a country, and make it impervious to the air; especially if the frost has been preceded by rain, which has soaked the surface. When this happens, the water which was filtering through the ground is all arrested and kept suspended in its capillary tubes by the pressure of the air, in the very same manner as the spirits are kept suspended in the instrument just now described by the thumb's shutting the hole A. A thaw melts the superficial ice, and allows the water to run in the same manner as the spirits run when the thumb is removed.

Common air is necessary for supporting the lives of most animals. If a small animal, such as a mouse or bird, be put under the receiver of an air-pump, and the air be exhausted, the animal will quickly be thrown into convulsions and fall down dead; if the air be immediately readmitted, the animal will sometimes revive, especially if the rarefaction has been briskly made, and has not been very great. We do not know that any breathing animal can bear the air to be reduced to $\frac{1}{4}$ of its ordinary density, nor even $\frac{1}{3}$; nor have we good evidence that an animal will ever recover if the rarefaction is pushed very far, although continued for a very short time.

But the mere presence of the air is by no means sufficient for preserving the life of the animal; for it is found, that an animal shut up in a vessel of air cannot live in it for any length of time. If a man be shut up in a box, containing a wine hogshead of air, he cannot live in it much above an hour, and long before this he will find his breathing very unsatisfactory and uneasy. A gallon of air will support him about a minute. A box EF (fig. 58.) may be made, having a pipe AB inserted into its top, and fitted with a very light valve at B, opening upwards. This pipe sends off a lateral branch *aDdC*, which enters the box at the bottom, and is also fitted with a light valve at C opening upwards. If a person breathe through the pipe, keeping his nostrils shut, it is evident that the air which he exhales will not enter the box by the hole B, nor return

through the pipe CD; and by this contrivance he will gradually employ the whole air of the box. With this apparatus experiments can be made without any risk or inconvenience, and the quantity of air necessary for a given time of easy breathing may be accurately ascertained.

How the air of our atmosphere produces this effect, is a question which does not belong to mechanical philosophy to investigate or determine. We can, however, affirm, that it is neither the pressure nor the elasticity of the air which is immediately concerned in maintaining the animal functions. We know that we can live and breathe with perfect freedom on the tops of the highest mountains. The valley of Quito in Peru, and the country round Gondur in Abyssinia, are so far elevated above the surface of the ocean, that the pressure and the elasticity of the air are one-third less than in the low countries; yet these are populous and healthy places. And, on the other hand, we know, that when an animal has breathed in any quantity of air for a certain time without renewal, it will not only be suffocated, but another animal put into this air will die immediately; and we do not find either the pressure or elasticity of the air remarkably diminished: it is indeed diminished, but by a very small quantity. Restoring the former pressure and elasticity has not the smallest tendency to prevent the death of the animal: for an animal will live no longer under a receiver that has its mouth inverted on water, than in one set upon the pump-plate covered with leather. Now when the receiver is set on water, the pressure of the atmosphere acts completely on the included air, and preserves it in the same state of elasticity.

In short, it is known that the air which has already served to maintain the animal functions has its chemical and alimentary properties completely changed, and is no longer fit for this purpose. So much of any mass of air as has really been thus employed is changed into what is called *fixed air* by Dr Black, or *carbonic acid* by the chemists of the Lavoisierian school. Any person may be convinced of this by breathing or blowing through a pipe immersed in lime water. Every expiration will produce white clouds on the water, till all the lime which it contains is precipitated in the form of pure chalk. In this case we know that the lime has combined with the fixed air.

The celebrated Dr Stephen Hales made many experiments, with a view to clear the air from the noxious vapour which he supposed to be emitted from the lungs.

He made use of the apparatus which we have been just now mentioning; and he put several diaphragms of thin woollen stuff into the box, and moistened them with various liquids. He found nothing so efficacious as a solution of potash. We now understand this perfectly. If the solution is not already saturated with fixed air, it will take it up as fast as it is produced, and thus will purify the air: a solution of caustic alkali therefore will have this effect till it is rendered quite mild.

These experiments have been repeated, and varied in many circumstances, in order to ascertain whether this fixed air was really emitted by the lungs, or whether the inspired air was in part changed into fixed air by its combination with some other substance. This is a question which comes properly in our way, and which

Effects of Air's pressure.

346

The nature of air when it has maintained animal functions is quite altered.

347

Hales's experiments to restore its former qualities, &c.

348

How it comes to be changed by breathing, and the nature of inspiration, &c.

Effects of
Air's pres-
sure.

the doctrines of pneumatics enable us to answer. If the fixed air be emitted in substance from the lungs, it does not appear how a renewal of the air into which it is emitted is necessary: for this does not hinder the subsequent emission; and the bulk of the air would be increased by breathing in it, viz. by the bulk of all the fixed air emitted; but, on the contrary, it is a little diminished. We must therefore adopt the other opinion; and the discoveries in modern chemistry enable us to give a pretty accurate account of the whole process. Fixed air is acknowledged to be a compound, of which one ingredient is found to constitute about $\frac{1}{3}$ of the whole atmospheric fluid; we mean vital air or the oxygen of Lavoisier. When this is combined with phlogiston, according to the doctrine of Stahl, or with charcoal, according to Lavoisier, the result is fixed air or carbonic acid. The change therefore which breathing makes on the air is the solution of this matter by vital air; and the use of air in breathing is the carrying off this noxious principle in the way of solution. When therefore the air is already so far saturated as not to dissolve this substance as fast as it is secreted, or must be secreted in the lungs, the animal suffers the pain of suffocation, or is otherwise mortally affected. Suffocation is not the only consequence; for we can remain for a number of seconds without breathing, and then we begin to feel the true pain of suffocation; but those who have been instantaneously struck down by an inspiration of fixed air, and afterwards recovered to life, complained of no such pain, and seemed to have suffered chiefly by a nervous affection. It is said (but we will not vouch for the truth of it), that a person may safely take a full inspiration of fixed air, if the passages of the nose be shut; and that unless these nerves are stimulated by the fixed air, it is not instantaneously mortal. But these are questions out of our present line of inquiry. They are questions of physiology, and are treated of in other places of this work. See ANATOMY and PHYSIOLOGY; see also LUNGS and RESPIRATION. Our business is to explain in what manner the pressure and elasticity of the air, combined with the structure and mechanism of the body, operate in producing this necessary secretion and removal of the matter discharged from the lungs in the act of breathing.

It is well ascertained, that the secretion is made from the mass of blood during its passage through the lungs. The blood delivered into the lungs is of a dark blackish colour, and it is there changed into a florid red. In the lungs it is exposed to the action of the air in a prodigiously extended surface: for the lungs consist of an inconceivable number of small vessels or bladders, communicating with each other and with the windpipe. These are filled with air in every inspiration. These vessels are everywhere in contact with minute blood-vessels. The blood does not *in toto* come into immediate contact with the air; and it would seem that it is only the thin serous part of it which is acted on by the air at the mouths of the vessels or pores, where it stands by capillary attraction. Dr Priestley found, that venous blood inclosed in thin bladders and other membranes was rendered florid by keeping the bladders in contact with abundance of pure vital air. We know also, that breath is moist or damp, and *must* have acquired this moisture in the lungs. It is immaterial whether this secretion of water or lymph (as the anatomists call it)

be furnished by mere exudation through simple pores, or by a vascular and organic secretion; in either case, some ingredient of the blood comes in contact with air in the lungs, and there unites with it. This is farther confirmed, by observing, that all breathing animals are warmer than the surrounding medium, and that by every process in which fixed air is formed from vital air heat is produced. Hence this solution in air of something from the blood has been assigned by many as the source of animal heat. We touch on these things in a very transitory way in this place, only in order to prove that, for the support of animal life, there must be a very extensive application of air to the blood, and that this is made in the lungs.

The question before us in this place is, How is this brought about by the weight and elasticity of the air? This is done in two ways; by the action of the muscles of the ribs, and by the action of the diaphragm and other muscles of the abdomen. The thorax or chest is a great cavity, completely filled by the lungs. The sides of this cavity are formed by the ribs. These are crooked or arched, and each is moveable round its two ends, one of them being inserted into the vertebrae of the back, and the other into the sternum or breast-bone. The rib turns in a manner resembling the handle of a drawer. The inspection of fig. 59. will illustrate this matter a little. Suppose the curves *ace*, *bkf*, *clg*, &c. to represent the ribs moveable round the extremities. Each succeeding rib is more bent than the one above it, and this curvature is both in the vertical and horizontal direction. Suppose each so broad as to project a little over its inferior like the tiles of a roof. It is evident, that if we take the lower one by its middle, and draw it out a little, moving it round the line *np*, it will bring out the next *dmb* along with it. Also, because the distance of the middle point *o* from the axis of motion *np* is greater than the distance of *m* from the axis *nb*, and because *o* will therefore describe a portion of a larger circle than *m* does, the rib *nop* will slide up a little under the rib *dmb*, or the rib *dmb* will overlap *nop* a little more than before; the distance *om* will therefore be diminished. The same must happen to all the superior ribs; but the change of distance will be less and less as we go upwards. Now, instead of this great breadth of the ribs overlapping each other, suppose each inferior rib connected with the one above it by threads or fibres susceptible of contraction at the will of man. The articulations *ea* of the first or upper rib with the spine and sternum are so broad and firm, that this rib can have little or no motion round the line *ae*; this rib therefore is as a fixture for the ends of all the contracting fibres: therefore, whenever the fibres which connect the second rib with the first rib contract, the second must rise a little, and also go outward, and will carry the lower ribs along with it; the third rib will rise still farther by the contraction of the muscles which connect it with the second, and so on: and thus the whole ribs are raised and thrown outward (and a little forward, because the articulation of each with the spine is considerably higher than that with the sternum), and the capacity of the thorax is enlarged by the contraction of its muscular covering. The direction of the muscular fibres is very oblique to the direction of the circular motion which it produces; from which circumstance it follows, that a very minute contraction of the

Muscles

Effects of
Air's pres-
sure.

muscles produces all the motion which is necessary. This indeed is not great; the whole motion of the lowest ribs is less than an inch in the most violent inspiration, and the whole contraction of the muscles of the 12 ribs does not exceed the eighth part of an inch, even supposing the intercostal muscles at right angles to the ribs; and being oblique, the contraction is still less (see BORELLI, SABATIER, MONRO, &c.) It would seem, that the intensity of the contractive power of a muscular fibre is easily obtained, but that the space through which it can be exerted is very limited; for in most cases nature places the muscles in situations of great mechanical disadvantage in this respect, in order to procure other conveniences.

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ICV.

But this is not the whole effect of the contraction of the intercostal muscles: since the compound action of the two sets of muscles, which cross each other from rib to rib like the letter X, is nearly at right angles to the rib, but is oblique to its plane, it tends to push the ribs closer on their articulations, and thus to press out the two pillars on which they are articulated. Thus, supposing *af* (fig. 60.) to represent the section of one of the vertebrae of the spine, and *cd* a section of the sternum, and *abc, fed*, two opposite ribs, with a lax thread *be* connecting them. If this thread be pulled upwards by the middle *g* till it is tight, it will tend to pull the points *b* and *e* nearer to each other, and to press the vertebra *af* and the sternum *cd* outwards. The spine being the chief pillar of the body, may be considered as immovable in the present instance. The sternum is sufficiently susceptible of motion for the present purpose. It remains almost fixed atop at its articulation with the first rib, but it gradually yields below; and thus the capacity of the thorax is enlarged in this direction also. The whole enlargement of the diameters of the thorax during inspiration is very small, not exceeding the fiftieth part of an inch in ordinary cases. This is easily calculated. Its quiescent capacity is about two cubic feet, and we never draw in more than 15 inches. Two spheres, one of which holds 2 cubic feet and the other 2 feet and 15 inches, will not differ in diameter above the fiftieth part of an inch.

The other method of enlarging the capacity of the thorax is very different. It is separated from the abdomen by a strong muscular partition called the *diaphragm*, which is attached to firm parts all around. In its quiescent or relaxed state it is considerably convex upwards, that is, towards the thorax, rising up into its cavity like the bottom of an ordinary quart bottle, only not so regular in its shape. Many of its fibres tend from its middle to the circumference, where they are inserted into firm parts of the body. Now suppose these fibres to contract. This must draw down its middle, or make it flatter than before, and thus enlarge the capacity of the thorax.

Physiologists are not well agreed as to the share which each of these actions has in the operation of enlarging the thorax. Many refuse all share of it to the intercostal muscles, and say that it is performed by the diaphragm alone. But the fact is, that the ribs are really observed to rise even while the person is asleep; and this cannot possibly be produced by the diaphragm, as these anatomists assert. Such an opinion shows either ignorance or neglect of the laws of pneumatics. If the capacity of the thorax were enlarged only by drawing down the

diaphragm, the pressure of the air would compress the ribs, and make them descend. And the simple laws of mechanics make it as evident as any proposition in geometry, that the contraction of the intercostal muscles *must* produce an elevation of the ribs and enlargement of the thorax; and it is one of the most beautiful contrivances of nature. It depends much on the will of the animal what share each of these actions shall have. In general, the greatest part is done by the diaphragm; and any person can breathe in such a manner that his ribs shall remain motionless; and, on the contrary, he can breathe almost entirely by raising his chest. In the first method of breathing, the belly rises during inspiration, because the contraction of the diaphragm compresses the upper part of the bowels, and therefore squeezes them outwards; so that an ignorant person would be apt to think that the breathing was performed by the belly, and that the belly is inflated with the air. The strait lacing of the women impedes the motion of the ribs, and changes the natural habit of breathing, or brings on an unnatural habit. When the mind is depressed, it is observed that the breathing is more performed by the muscles of the thorax; and a deep sigh is always made in this way.

These observations on the manner in which the capacity of the chest can be enlarged were necessary, before we can acquire a just notion of the way in which the mechanical properties of air operate in applying it to the mass of blood during its passage through the lungs. Suppose the thorax quite empty, and communicating with the external air by means of the trachea or wind-pipe, it would then resemble a pair of bellows. Raising the boards corresponds to the raising of the ribs; and we might imitate the action of the diaphragm by forcibly pulling outwards the folded leather which unites them. Thus their capacity is enlarged, and the air rushes in at the nozzle by its weight in the same manner as water would do. The thorax differs from bellows only in this respect, that it is filled by the lungs, which is a vast collection of little bladders, like the holes in a piece of fermented bread, all communicating with the trachea, and many of them with each other. When the chest is enlarged, the air rushes into them all in the same manner as into the single cavity of an empty thorax. It cannot be said with propriety that they are inflated: all that is done is the *allowing* the air to come in. At the same time, as their membranous covering must have some thickness, however small, and some elasticity, it is not unlikely that, when compressed by expiration, they tend a little to recover their former shape, and thus aid the voluntary action of the muscles. It is in this manner that a small bladder of caoutchouc swells again after compression, and fills itself with air or water. But this cannot happen except in the most minute vesicles: those of sensible bulk have not elasticity enough for this purpose. The lungs of birds, however, have some very large bladders, which have a very considerable elasticity, and recover their shape and size with great force after compression, and thus fill themselves with air. The respiration of these animals is considerably different from that of land animals, and their muscles act chiefly in expiration. This will be explained by and by as a curious variety in the pneumatic instrument.

This account of the manner in which the lungs are

Effect of
Air's pres-
sure.

Effects of
Air's pres-
sure.

349
We take in
air not by
our own
action, but
by external
pressure.

filled with air does not seem agreeable to the notions we entertain of it. We seem to suck in the air; but although it be true that we act, and exert force, in order to get air into our lungs, it is not by our action, but by external pressure, that it does come in. If we apply our mouth to the top of a bottle filled with water, we find that no draught, as we call it, of our chest will suck in any of the water; but if we suck in the very same manner at the end of a pipe immersed in water, it follows immediately. Our interest in the thing makes us connect in imagination our own action with the effect, without thinking on the many steps which may intervene in the train of natural operations; and we consider the action as the immediate cause of the air's reception into the lungs. It is as if we opened the door, and took in by the hand a person who was really pushed in by the crowd without. If an incision be made into the side of the thorax, so that the air can get in by that way, when the animal acts in the usual manner, the air will really come in by this hole, and fill the space between the lungs and thorax; but no air is sucked into the lungs by this process, and the animal is as completely suffocated as if the windpipe were shut up. And, on the other hand, if a hole be made into the lungs without communicating with the thorax, the animal will breathe through this hole, though the windpipe be stopped. This is successfully performed in cases of patients whose trachea is shut up by accident or by inflammation; only it is necessary that this perforation be made into a part of the lungs where it may meet with some of the great pulmonary passages; for if made into some remote part of a lobe, the air cannot find its way into the rest of the lungs through such narrow passages, obstructed too by blood, &c.

350
Nature of
expiration

We have now explained, on pneumatical principles, the process of inspiration. The expiration is chiefly performed by the natural tone of the parts. In the act of inspiration the ribs were raised and drawn outwards in opposition to the elasticity of the solids themselves; for although the ribs are articulated at their extremities, the articulations are by no means such as to give a free and easy motion like the joints of the limbs. This is particularly the case in the articulations with the sternum, which are by no means fitted for motion. It would seem that the motion really produced here is chiefly by the yielding of the cartilaginous parts and the bending of the rib; when therefore the muscles which produced this effect are allowed to relax, the ribs again collapse. Perhaps this is assisted a little by the action of the long muscles which come down across the ribs without being inserted into them. These may draw them together a little, as we compress a loose bundle by a string.

In like manner, when the diaphragm was drawn down, it compressed the abdomen in opposition to the elasticity of all the viscera contained in it, and to the elasticity and tone of the teguments and muscles which surround it. When therefore the diaphragm is relaxed, these parts push it up again into its natural situation, and in doing this expel the air from the lungs.

353
It requires
no effort.

If this be a just account of the matter, expiration should be performed without any effort. This accordingly is the case. We feel that, after having made an ordinary easy inspiration, it requires the continuance of the effort to keep the thorax in this enlarged state, and

that all that is necessary for expiration is to cease to act. No person feels any difficulty in emptying the lungs; but weak people often feel a difficulty of inspiration, and compare it to the feeling of a weight on their breast; and expiration is the last motion of the thorax in a dying person.

Effects of
Air's pres-
sure.

But nature has also given us a mechanism by which we can expire, namely, the abdominal muscles; and when we have finished an ordinary and easy expiration, we can still expel a considerable bulk of air (nearly half of the contents of the lungs) by contracting the abdominal muscles. These, by compressing the body, force up its moveable contents against the diaphragm, and cause it to rise further into the thorax, acting in the same manner as when we expel the *fæces per anum*. When a person breathes out as much air as he can in this manner, he may observe that his ribs do not collapse during the whole operation.

There seems then to be a certain natural unconstrained state of the vesicles of the lungs, and a certain quantity of air necessary for keeping them of this size. It is probable that this state of the lungs gives the freest motion to the blood. Were they more compressed, the blood vessels would be compressed by the adjoining vesicles; were they more lax, the vessels would be more crooked, and by this means obstructed. The frequent inspirations gradually change this air by mixing fresh air with it, and at every expiration carrying off some of it. In catarrhs and inflammations, especially when attended with suppuration, the small passages into the remote vessels are obstructed, and thus the renewal of air in them will be prevented. The painful feeling which this occasions causes us to expel the air with violence, shutting the windpipe, till we have exerted strongly with the abdominal muscles, and made a strong compression on the lower part of the thorax. We then open the passage suddenly, and expel the air and obstructing matter by violent coughing.

We have said, that birds exhibit a curious variety in the process of breathing. The muscles of their wings being so very great, required a very extensive insertion, and this is one use of the great breast-bone. Another use of it is, to form a firm partition to hinder the action of these muscles from compressing the thorax in the act of flying: therefore the form of their chest does not admit of alternate enlargement and contraction to that degree as in land animals. Moreover, the muscles of their abdomen are also very small; and it would seem that they are not sufficient for producing the compression on the bowels which is necessary for carrying on the process of concoction and digestion. Instead of aiding the lungs, they receive help from them.

353
Process of
breathing
in birds.

In an ostrich, the lungs consist of a fleshy part A, A (fig. 61.), composed of vesicles like those of land animals, and, like theirs, serving to expose the blood to the action of the air. Besides these, they have on each side four large bags B, C, D, E, each of which has an orifice G communicating with the trachea; but the second, C, has also an orifice H, by which it communicates with another bag F situated below the rest in the abdomen. Now, when the lungs are compressed by the action of the diaphragm, the air in C is partly expelled by the trachea through the orifice G, and partly driven through the orifice H into the bag F; which

Plate
CCCCV.

of which is then allowed to receive it; because the same action which compresses the lungs enlarges the abdomen. When the thorax is enlarged, the bag C is partly supplied with fresh air through the trachea, and partly from the bag F. As the lungs of other animals resemble a common bellows, the lungs of birds resemble the smith's bellows with a partition; and anatomists have discovered passages from this part of the lungs into their hollow bones and quills. We do not know all the uses of this contrivance; and only can observe, that this alternate action must assist the muscles of the abdomen in promoting the motion of the food along the alimentary canal, &c. We can distinctly observe in birds that their belly dilates when the chest collapses, and *vice versa*, contrary to what we see in the land animals. Another use of this double passage may be to produce a circulation of air in the lungs, by which a compensation is made for the smaller surface of action on the blood: for the number of small vesicles, of equal capacity with these large bags, gives a much more extensive surface.

If we try to raise mercury in a pipe by the action of the chest alone, we cannot raise it above two or three inches; and the attempt is both painful and hazardous. It is painful chiefly in the breast, and it provokes coughing. Probably the fluids ooze through the pores of the vesicles by the pressure of the surrounding parts.

On the other hand, we can by expiration support mercury about five or six inches high: but this also is very painful, and apt to produce extravasation of blood. This seems to be done entirely by the abdominal muscles.

34 The operation properly termed SUCKING is totally different from breathing, and resembles exceedingly the action of a common pump. Suppose a pipe held in the mouth, and its lower end immersed in water. We fill the mouth with the tongue, bringing it forward, and applying it closely to the teeth and to the palate; we then draw it back, or bend it downwards (behind) from the palate, thus leaving a void. The pressure of the air on the cheeks immediately depresses them, and applies them close to the gums and teeth; and its pressure on the water in the vessel causes it to rise through the pipe into the empty part of the mouth, which it quickly fills. We then push forward the tip of the tongue, below the water, to the teeth, and apply it to them all round, the water being above the tongue, which is kept much depressed. We then apply the tongue to the palate, beginning at the tip, and gradually going backward in this application. By this means the water is gradually forced backward by an operation similar to that of the gullet in swallowing. This is done by contracting the gullet above and relaxing it below, just as we would empty a gut of its contents by drawing our closed hand along it. By this operation the mouth is again completely occupied by the tongue, and we are ready for repeating the operation. Thus the mouth and tongue resemble the barrel and piston of a pump; and the application of the tip of the tongue to the teeth performs the office of the valve at the bottom of the barrel, preventing the return of the water into the pipe. Although usual, it is not absolutely necessary, to withdraw the tip of the tongue, making a void before the tongue. Sucking may be performed by merely separating the tongue gradually from the

palate, beginning at the root. If we withdraw the tip of the tongue a very minute quantity, the water gets in and flows back above the tongue.

The action of the tongue in this operation is very powerful; some persons can raise mercury 25 inches: but this strong exertion is very fatiguing, and the soft parts are prodigiously swelled by it. It causes the blood to ooze plentifully through the pores of the tongue, fauces, and palate, in the same manner as if a cupping-glass and syringe were applied to them; and, when the inside of the mouth is excoriated or tender, as is frequent with infants, even a very moderate exertion of this kind is accompanied with extravasation of blood. When children suck the nurse's breast, the milk follows their exertion by the pressure of the air on the breast; and a weak child, or one that withholds its exertions on account of pain from the above-mentioned cause, may be assisted by a gentle pressure of the hand on the breast: the infant pupil of nature, without any knowledge of pneumatics, frequently helps itself by pressing its face to the yielding breast.

In the whole of this operation the breathing is performed through the nostrils; and it is a prodigious distress to an infant when this passage is obstructed by mucus. We beg to be forgiven for observing by the way, that this obstruction may be almost certainly removed for a little while, by rubbing the child's nose with any liquid of quick evaporation, or even with water.

355 The operation in drinking is not very different from And of drinking, which is very similar. that in sucking: we have indeed little occasion here to suck, but we must do it a little. Dogs and some other animals cannot drink, but only lap the water into their mouths with their tongue, and then swallow it. The gallinaceous birds seem to drink very imperfectly; they seem merely to dip their head into the water up to the eyes till their mouth is filled with water, and then holding up the head, it gets into the gullet by its weight, and is then swallowed. The elephant drinks in a very complicated manner; he dips his trunk into the water, and fills it by making a void in his mouth: this he does in the contrary way to man. After having depressed his tongue, he begins the application of it to the palate at the root, and by extending the application forward, he expels the air by the mouth which came into it from the trunk. The process here is not very unlike that of the condensing syringe without a piston valve, described in n^o 58, in which the external air (corresponding here to the air in the trunk) enters by the hole F in the side, and is expelled through the hole in the end of the barrel; by this operation the trunk is filled with water: then he lifts his trunk out of the water, and bringing it to his mouth, pours the contents into it, and swallows it. On considering this operation, it appears that, by the same process by which the air of the trunk is taken into the mouth, the water could also be taken in, to be afterwards swallowed: but we do not find, upon inquiry, that this is done by the elephant; we have always observed him to drink in the manner now described. In either way it is a double operation, and cannot be carried on any way but by alternately sucking and swallowing, and while one operation is going on the other is interrupted; whereas man can do both at the same time. Nature seems to delight in exhibiting to rational observers her inexhaustible variety of resource; for many insects, which drink with a trunk, drink without interruption: yet we

Effects of
Air's pres-
sure.

do not call in question the truth of the aphorism, *Natura maxime simplex et semper sibi consona*, nor doubt but that, if the whole of her purpose were seen, we should find that her process is the simplest possible: for Nature, or Nature's God, is wise above our wisest thoughts, and simplicity is certainly the choice of wisdom: but alas! it is generally but a small and the most obvious part of her purpose that we can observe or appreciate. We seldom see this simplicity of nature stated to us, except by some system-maker, who has found a principle which somehow tallies with a considerable variety of phenomena, and then cries out, *Frustra fit per plura quod fieri potest per pauciora*.

356
Mode of
keeping up
a continued
blast with a
blow-pipe.

There is an operation similar to that of the elephant, which many find a great difficulty in acquiring, viz. keeping up a continued blast with a blow-pipe. We would desire our chemical reader to attend minutely to the gradual action of his tongue in sucking, and he will find it such as we have described. Let him attend particularly to the way in which the tip of the tongue performs the office of a valve, preventing the return of the water into the pipe: the same position of the tongue would hinder air from coming into the mouth. Next let him observe, that in swallowing what water he has now got lodged above his tongue, he continues the tip of the tongue applied to the teeth; now let him shut his mouth, keeping his lips firm together, the tip of the tongue at the teeth, and the whole tongue forcibly kept at a distance from the palate; bring up the tongue to the palate, and allow the tip to separate a little from the teeth; this will expel the air into the space between the fauces and cheeks, and will blow up the cheeks a little: then, acting with the tip of the tongue as a valve, hinder this air from getting back, and depressing the tongue again, more air (from the nostrils) will get into the mouth, which may be expelled into the space without the teeth as before, and the cheeks will be more inflated: continue this operation, and the lips will no longer be able to retain it, and it will ooze through as long as the operation is continued. When this has become familiar and easy, take the blow-pipe, and there will be no difficulty in maintaining a blast as uniform as a smith's bellows, breathing all the while through the nostrils. The only difficulty is the holding the pipe: this fatigues the lips; but it may be removed by giving the pipe a convenient shape, a pretty flat oval, and wrapping it round with leather or thread.

Another phenomenon depending on the principles already established, is the land and sea-breeze in the warm countries.

357
Nature of
the land
and sea
breeze in
warm
countries.

We have seen that air expands exceedingly by heat; therefore heated air, being lighter than an equal bulk of cold air, must rise in it. If we lay a hot stone in the sunshine in a room, we shall observe the shadow of the stone surrounded with a fluttering shadow of different degrees of brightness, and that this flutter rises rapidly in a column above the stone. If we hold an extinguished candle near the stone, we shall see the smoke move towards the stone, and then ascend up from it. Now, suppose an island receiving the first rays of the sun in a perfectly calm morning; the ground will soon be warmed, and will warm the contiguous air. If the island be mountainous, this effect will be more remarkable; because the inclined sides of the hills will receive the light more directly: the midland air will therefore be most

warmed: the heated air will rise, and that in the middle will rise fastest; and thus a current of air upwards will begin, which must be supplied by air coming in from all sides, to be heated and to rise in its turn; and thus the morning *sea-breeze* is produced, and continues all day. This current will frequently be reversed during the night, by the air cooling and gliding down the sides of the hills, and we shall have the *land-breeze*.

It is owing to the same cause that we have a circulation of air in mines which have the mouths of their shafts of unequal heights. The temperature underground is pretty constant through the whole year, while that of the atmosphere is extremely variable. Now, suppose a mine having a long horizontal drift, communicating between two pits or shafts, and that one of these shafts terminates in a valley, while the other opens on the brow of a hill perhaps 100 feet higher. Let us further suppose it summer, and the air heated to 65° , while the temperature of the earth is but 45° ; this last will be also the temperature of the air in the shafts and the drift. Now, since air expands nearly 24 parts in 10000 by one degree of heat, we shall have an odds of pressure at the bottom of the two shafts equal to nearly the 20th part of the weight of a column of air 100 feet high (100 feet being supposed the difference of the heights of the shafts). This will be about six ounces on every square foot of the section of the shaft. If this pressure could be continued, it would produce a prodigious current of air down the long shaft, along the drift, and up the short shaft. The weight of the air acting through 100 feet would communicate to it the velocity of 80 feet per second: divide this by $\sqrt{20}$, that is, by 4.5, and we shall have 18 feet per second for the velocity: this is the velocity of what is called a brisk gale. This pressure would be continued, if the warm air which enters the long shaft were cooled and condensed as fast as it comes in; but this is not the case. It is however cooled and condensed, and a current is produced sufficient to make an abundant circulation of air along the whole passage; and care is taken to dispose the shafts and conduct the passages in such a manner that no part of the mine is out of the circle. When any new lateral drift is made, the renewal of air at its extremity becomes more imperfect as it advances; and when it is carried a certain length, the air stagnates and becomes suffocating, till either a communication can be made with the rest of the mine, or a shaft be made at the end of this drift.

As this current depends entirely on the difference of temperature between the air below and that above, it must cease when this difference ceases. Accordingly, in the spring and autumn, the miners complain much of stagnation; but in summer they never want a current from the deep pits to the shallow, nor in the winter a current from the shallow pits to the deep ones. It frequently happens also, that in mineral countries the chemical changes which are going on in different parts of the earth make differences of temperature sufficient to produce a sensible current.

It is easy to see that the same causes must produce a current down our chimneys in summer. The chimney is colder than the summer air, and must therefore condense it, and it will come down and run out at the doors and windows.

And this naturally leads us to consider a very important effect of the expansion and consequent ascent of air draught in chimneys.

Effects of
Air's pres-
sure.

358
Circulation
of air in
mines.

359
The nature
of what is
called the
draught in
chimneys.

by heat, namely the drawing (as it is called) of chimneys. The air which has contributed to the burning of fuel must be intensely heated, and will rise in the atmosphere. This will also be the case with much of the surrounding air which has come very near the fire, although not in contact with it. If this heated air be made to rise in a pipe, it will be kept together, and therefore will not soon cool and collapse: thus we shall obtain a long column of light air, which will rise with a force so much the greater as the column is longer or more heated. Therefore the taller we make the chimney, or the hotter we make the fire, the more rapid will be the current, or the draught or suction, as it is injudiciously called, will be so much the greater. The ascensional force is the difference between the weight of the column of heated air in the funnel and a column of the surrounding atmosphere of equal height. We increase the draught, therefore, by increasing the perpendicular height of the chimney. Its length in a horizontal direction gives no increase, but, on the contrary, diminishes the draught by cooling the air before it gets into the effective part of the funnel. We increase the draught also by obliging all the air which enters the chimney to come very near the fuel; therefore a low mantle-piece will produce this effect; also filling up all the spaces on each side of the grate. When much air gets in above the fire, by having a lofty mantle-piece, the general mass of air in the chimney cannot be much heated. Hence it must happen that the greatest draught will be produced by bringing down the mantle-piece to the very fuel; but this converts a fire-place into a furnace, and by thus sending the whole air through the fuel, causes it to burn with great rapidity, producing a prodigious heat; and this producing an increase of ascensional force, the current becomes furiously rapid, and the heat and consumption of fuel immense. If the fire-place be a cube of a foot and a half, and the front closed by a door, so that all the air must enter through the bottom of the grate, a chimney of 15 or 20 feet high, and sufficiently wide to give passage to all the expanded air which can pass through the fire, will produce a current which will roar like thunder, and a heat sufficient to run the whole inside into a lump of glass.

All that is necessary, however, in a chamber fire-place, is a current sufficiently great for carrying up the smoke and vitiated air of the fuel. And as we want also the enlivening flutter and light of the fire, we give the chimney-piece both a much greater height and width than what is merely necessary for carrying up the smoke, only wishing to have the current sufficiently determinate and steady for counteracting any occasional tendency which it may sometimes have to come into the room. By allowing a greater quantity of air to get into the chimney, heated only to a moderate degree, we produce a more rapid renewal of the air of the room: did we oblige it to come so much nearer the fire as to produce the same renewal of the air in consequence of a more rapid current, we should produce an inconvenient heat. But in this country, where pit-coal is in general so very cheap, we carry this indulgence to an extreme; or rather we have not studied how to get all the desired advantages with economy. A much smaller renewal of air than we commonly produce is abundantly wholesome and pleasant, and we may have

all the pleasure of the light and flame of the fuel at much less expence, by contracting greatly the passage into the vent. The best way of doing this is by contracting the brick-work on each side behind the mantle-piece, and reducing it to a narrow parallelogram, having the back of the vent for one of its long sides. Make an iron plate to fit this hole, of the same length, but broader, so that it may lie sloping, its lower edge being in contact with the foreface of the hole, and its upper edge leaning on the back of the vent. In this position it shuts the hole entirely. Now let the plate have a hinge along the front or lower edge, and fold up like the lid of a chest. We shall thus be able to enlarge the passage at pleasure. In a fire-place fit for a room of 24 feet by 18, if this plate may be about 18 inches long from side to side, and folded back within an inch or an inch and a half of the wall, this will allow passage for as much air as will keep up a very cheerful fire; and by raising or lowering this REGISTER, the fire may be made to burn more or less rapidly. A free passage of half an inch will be sufficient in weather that is not immoderately cold. The principle on which this construction produces its effect is, that the air which is in the front of the fire, and much warmed by it, is not allowed to get into the chimney, where it would be immediately hurried up the vent, but rises up to the ceiling and is diffused over the whole room. This double motion of the air may be distinctly observed by opening a little of the door and holding a candle in the way. If the candle be held near the floor, the flame will be blown into the room; but if held near the top of the door, the flame will be blown outward.

But the most perfect method of warming an apartment in these temperate climates, where we can indulge in the cheerfulness and sweet air produced by an open fire, is what we call a stove-grate, and our neighbours on the continent call a chapelle, from its resemblance to the chapels or oratories in the great churches.

In the great chimney-piece, which, in this case, may be made even larger than ordinary, is set a smaller one fitted up in the same stile of ornament, but of a size no greater than is sufficient for holding the fuel. The sides and back of it are made of iron (cast iron is preferable to hammered iron, because it does not so readily calcine), and are kept at a small distance from the sides and back of the main chimney-piece, and are continued down to the hearth, so that the ash-pit is also separated. The pipe or chimney of the stove grate is carried up behind the ornaments of the mantle-piece till it rises above the mantle-piece of the main chimney-piece, and is fitted with a register or damper-plate turning round a transverse axis. The best form of this register is that which we have recommended for an ordinary fire-place, having its axis or joint close at the front; so that when it is open or turned up, the burnt air and smoke striking it obliquely, are directed with certainty into the vent, without any risk of reverberating and coming out into the room. All the rest of the vent is shut up by iron plates or brick-work out of sight.

The effect of this construction is very obvious. The fuel, being in immediate contact with the back and its sides of the grate, heat them to a great degree, and they heat the air contiguous to them. This heated

Effects of
Air's pressure.

360
Description
of a stove-
grate or
chapelle.

361

air

Effects of
Air's pres-
sure.

air cannot get up the vent, because the passages above these spaces are shut up. It therefore comes out into the room; some of it goes into the real fire-place and is carried up the vent, and the rest rises to the ceiling and is diffused over the room.

It is surprising to a person who does not consider it with skill how powerfully this grate warms a room. Less than one-fourth of the fuel consumed in an ordinary fire-place is sufficient; and this with the same cheerful blazing hearth and salutary renewal of air. It even requires attention to keep the room cool enough. The heat communicated to those parts in contact with the fuel is needlessly great; and it will be a considerable improvement to line this part with very thick plates of cast iron, or with tiles made of fire-clay which will not crack with the heat. These, being very bad conductors, will make the heat, ultimately communicated to the air, very moderate. If, with all these precautions, the heat should be found too great, it may be brought under perfect management by opening passages into the vent from the lateral spaces. These may be valves or trap-doors moved by rods concealed behind the ornaments.

Thus we have a fire-place under the most complete regulation, where we can always have a cheerful fire without being for a quarter of an hour incommoded by the heat; and we can as quickly raise our fire, when too low, by hanging on a plate of iron on the front, which shall reach as low as the grate. This in five minutes will blow up the fire into a glow; and the plate may be sent out of the room, or set behind the stove-grate out of sight.

The propriety of inclosing the ash-pit is not so obvious; but if this be not done, the light ashes, not finding a ready passage up the chimney, will come out into the room along with the heated air.

We do not consider in this place the various extraneous circumstances which impede the current of air in our chimneys and produce smoky houses: these will be treated of, and the methods of removing or remedying them, under the article SMOKE. We consider at present only the theory of this motion in general, and the modifications of its operation arising from the various purposes to which it may be applied.

Under this head we shall next give a general account and description of the method of warming apartments by stoves. A STOVE in general is a fire-place shut up on all sides, having only a passage for admitting the air to support the fire, and a tube for carrying off the vitiated air and smoke; and the air of the room is warmed by coming into contact with the outside of the stove and flue. The general principle of construction, therefore, is very simple. The air must be made to come into as close contact as possible with the fire, or even to pass through it, and this in such quantities as just to consume a quantity of fuel sufficient for producing the heat required; and the stove must be so constructed, that both the burning fuel and the air which has been heated by it shall be applied to as extensive a surface as possible of furnace, all in contact with the air of the room; and the heated air within the stove must not be allowed to get into the funnel which is to carry it off till it is too much cooled to produce any considerable heat on the outside of the stove.

In this temperate climate no great ingenuity is ne-

cessary for warming an ordinary apartment; and stoves are made rather to please the eye as furniture than as economical substitutes for an open fire of equal caloric power. But our neighbours on the continent, and especially towards the north, where the cold of winter is intense and fuel very dear, have bestowed much attention on their construction, and have combined ingenious economy with every elegance of form. Nothing can be handsomer than the stoves of Fayencerie that are to be seen in French Flanders, or the Russian stoves at St Petersburg, finished in stucco. Our readers will not, therefore, be displeased with a description of them. In this place, however, we shall only consider a stove in general as a subject of pneumatical discussion, and we refer our readers to the article STOVE for an account of them as articles of domestic accommodation.

The general form, therefore, of a stove, and of which all others are only modifications adapted to circumstances of utility or taste, is as follows:

MIKL (fig. 62.) is a quadrangular box of any size in the directions MI IK. The inside width from front to back is pretty constant, never less than ten inches, and rarely extending to 20; the included space is divided by a great many partitions. The lowest chamber AB is the receptacle for the fuel, which lies on the bottom of the stove without any grate: this fire-place has a door AO turning on hinges, and in this door is a very small wicket P: the roof of the fire-place extends to within a very few inches of the farther end, leaving a narrow passage B for the flame. The next partition cC is about eight inches higher, and reaches almost to the other end, leaving a narrow passage for the flame at C. The partitions are repeated above, at the distance of eight inches, leaving passages at the ends, alternately disposed as in the figure; the last of them H communicates with the room vent. This communication may be regulated by a plate of iron, which can be slid across it by means of a rod or handle which comes through the side. The more usual way of shutting up this passage is by a sort of pan or bowl of earthen ware, which is whelmed over it with its brim resting in sand contained in a groove formed all round the hole. This damper is introduced by a door in the front, which is then shut. The whole is set on low pillars, so that its bottom may be a few inches from the floor of the room: it is usually placed in a corner, and the apartments are so disposed that their chimneys can be joined in stacks as with us.

Some straw or wood-shavings are first burnt on the hearth at its farther end. This warms the air in the stove, and creates a determined current. The fuel is then laid on the hearth close by the door, and pretty much piled up. It is now kindled; and the current being already directed to the vent, there is no danger of any smoke coming out into the room. Effectually to prevent this, the door is shut, and the wicket P opened. The air supplied by this, being directed to the middle or bottom of the fuel, quickly kindles it, and the operation goes on.

The aim of this construction is very obvious. The flame and heated air are retained as long as possible within the body of the stove by means of the long passages; and the narrowness of these passages obliges the flame to come in contact with every particle of soot, so as to consume it completely, and thus convert the whole combustible

Effects of
Air's pres-
sure.

363
General
form of a
stove.

Plate
CCCCV.

362
Mode of
warming
apartments
by stoves.

364
The Aim and
effects of
this con-
struction.

Effects of a pref-
ure.

combustible matter of the fuel into heat. For want of this a very considerable portion of our fuel is wasted by our open fires, even under the very best management: the foot which sticks to our vents is very inflammable, and a pound weight of it will give as much if not more heat than a pound of coal. And what sticks to our vents is very inconsiderable in comparison with what escapes unconsumed at the chimney top. In fires of green wood, peat, and some kinds of pit-coal, nearly $\frac{1}{2}$ of the fuel is lost in this way; but in these stoves there is hardly ever any mark of foot to be seen; and even this small quantity is produced only after lighting the fires. The volatile inflammable matters are expelled from parts much heated indeed, but not so hot as to burn; and some of it charred or half-burnt cannot be any further consumed, being enveloped in flame and air already vitiated and unfit for combustion. But when the stove is well heated, and the current brisk, no part of the foot escapes the action of the air.

The hot air retained in this manner in the body of the stove is applied to its sides in a very extended surface. To increase this still more, the stove is made narrower from front to back in its upper part; a certain breadth is necessary below, that there may be room for fuel. If this breadth were preserved all the way up, much heat would be lost, because the heat communicated to the partitions of the stove does no good. By diminishing their breadth, the proportion of useful surface is increased. The whole body of the stove may be considered as a long pipe folded up, and its effect would be the greatest possible if it really were so; that is, if each partition C, d D, &c. were split into two, and a free passage allowed between them for the air of the room. Something like this will be observed afterwards in some German stoves.

It is with the same view of making an extensive application of a hot surface to the air, that the stove is not built in the wall, nor even in contact with it, nor with the floor: for by its detached situation, the air in contact with the back, and with the bottom (where it is hottest), is warmed, and contributes at least one half of the whole effect; for the great heat of the bottom makes its effect on the air of the room at least equal to that of the two ends. Sometimes a stove makes part of the wall between two small rooms, and is found sufficient.

It must be remarked, on the whole, that the effect of a stove depends much on keeping in the room the air already heated by it. This is so remarkably the case, that a small open fire in the same room will be so far from increasing its heat, that it will greatly diminish it: it will even draw the warm air from a suite of adjoining apartments. This is distinctly observed in the houses of the English merchants in St Petersburg: their habits of life in Britain make them uneasy without an open fire in their sitting rooms; and this obliges them to heat all their stoves twice a day, and their houses are cooler than those of the Russians who heat them only once. In many German houses, especially of the lower class, the fire-place of the stove does not open into the room, but into the yard or a lobby, where all the fires are lighted and tended; by this means is avoided the expence of warm air which must have been carried off by the stove: but it is evident, that this must be very unpleasant, and cannot be wholesome. We must breathe the same quantity of stagnant air loaded with all the va-

pours and exhalations which must be produced in every inhabited place. Going into one of these houses from the open air, is like putting one's head into a stew-pan or under a pie-crust, and quickly nauseates us who are accustomed to fresh air and cleanliness. In these countries it is a matter almost of necessity, to fumigate the rooms with frankincense and other gums burnt. The censer in ancient worship was in all probability an utensil introduced by necessity for sweetening or rendering tolerable the air of a crowded place: and it is a constant practice in the Russian houses for a servant to go round the room after dinner, waving a censer with some gums burning on bits of charcoal.

The account now given of stoves for heating rooms, and of the circumstances which must be attended to in their construction, will equally apply to hot walls in gardening, whether within or without doors. The only new circumstance which this employment of a flue introduces, is the attention which must be paid to the equality of the heat, and the gradation which must be observed in different parts of the building. The heat in the flue gradually diminishes as it recedes from the fire-place, because it is continually giving out heat to the flue. It must therefore be so conducted through the building by frequent returns, that in every part there may be a mixture of warmer and cooler branches of the flue, and the final chimney should be close by the fire-place. It would, however, be improper to run the flue from the end of the floor up to the ceiling, where the second horizontal pipe would be placed, and then return it downward again and make the third horizontal flue adjoining to the first, &c. This would make the middle of the wall the coldest. If it is the flue of a greenhouse, this would be highly improper, because the upper part of the wall can be very little employed; and in this case it is better to allow the flue to proceed gradually up the wall in its different returns, by which the lowest part would be the warmest, and the heated air will ascend among the pots and plants; but in a hot wall, where the trees are to receive heat by contact, some approximation to the above method may be useful.

In the hypocausta and sudaria of the Greeks and Romans, the flue was conducted chiefly under the floors.

Malt-kilns are a species of stove which merit our attention. Many attempts have been made to improve them on the principal of flue stoves; but they have been unsuccessful, because heat is not what is chiefly wanted in malting: it is a copious current of very dry air to carry off the moisture. We must refer the examination of this subject also to the article STOVE, and proceed to consider the current of heated air in the chief varieties of furnaces.

All that is to be attended to in the different kinds of melting furnaces is, that the current of air be sufficiently rapid, and that it be applied in as extensive a surface as possible to the substance to be melted. The more rapid the current it is the hotter, because it is consuming more fuel; and therefore its effect increases in a higher proportion than its rapidity. It is doubly effectual if twice as hot; and if it then be twice as rapid, there is twice the quantity of doubly hot air applied to the subject; it would therefore be four times more powerful. This is procured by raising the chimney of the furnace to a greater height. The close application of it to the subject can hardly be laid down in general terms, be-
cause

Effects of
Air's pres-
sure.

365
Of hot
walls in
gardening,
&c.

366
Malt-kilns
a species of
stove.

367
Of the cur-
rent of air
in melting
furnaces.

Effects of
Air's pres-
sure.

368
In reverberatory furnaces,

cause it depends on the precise circumstances of each case.

In reverberatory furnaces, such as refining furnaces for gold, silver, and copper, the flame is made to play over the surface of the melted metal. This is produced entirely by the form of the furnace, by making the arch of the furnace as low as the circumstances of the manipulation will allow (See FURNACE, p. 509.). Experience has pointed out in general the chief circumstances of their construction, viz. that the fuel should be at one end on a grate, through which the air enters to maintain the fire; and that the metal should be placed on a level floor between the fuel and the tall chimney which produces the current. But there is no kind of furnace more variable in its effect, and almost every place has a small peculiarity of construction, on which its pre-eminence is rested. This has occasioned many whimsical varieties in their form. This uncertainty seems to depend much on a circumstance rather foreign to our present purpose; but as we do not observe it taken notice of by mineralogical writers, we beg leave to mention it here. It is not heat alone that is wanted in the refining of silver by lead, for instance. We must make a continual application to its surface of air, which has not contributed to the combustion of the fuel. Any quantity of the hottest air, already saturated with the fuel, may play on the surface of the metal for ever, and keep it in the state of most perfect fusion, but without refining it in the least. Now, in the ordinary construction of a furnace, this is much the case. If the whole air has come in by the grate, and passed through the middle of the fuel, it can hardly be otherwise than nearly saturated with it; and if air be also admitted by the door (which is generally done or something equivalent), the pure air lies above the vitiated air, and during the passage along the horizontal part of the furnace, and along the surface of the metal, it still keeps above it, at least there is nothing to promote their mixture. Thus the metal does not come into contact with air fit to act on the base metal and calcine it, and the operation of refining goes on slowly. Trifling circumstances in the form of the arch or canal may tend to promote the jumbling of the airs together, and thus render the operation more expeditious; and as these are but ill understood, or perhaps this circumstance not attended to, no wonder that we see these considered as so many nostrums of great importance. It were therefore worth while to try the effect of changes in the form of the roof directed to this very circumstance. Perhaps some little prominence down from the arch of the reverberatory would have this effect, by suddenly throwing the current into confusion. If the additional length of passage do not cool the air too much, we should think that if there were interposed between the fuel and the refining floor a passage twisted like a cork-screw, making just half a turn, it would be most effectual: for we imagine, that the two airs, keeping each to their respective sides of the passage, would by this means be turned upside down, and that the pure stratum would now be in contact with the metal, and the vitiated air would be above it.

369
And in the
glass-house
furnaces.

The glasshouse furnace exhibits the chief variety in the management of the current of heated air. In this it is necessary that the hole at which the workman dips his pipe into the pot shall be as hot as any part of the

furnace. This could never be the case, if the furnace had a chimney situated in a part above the dipping-hole; for in this case cold air would immediately rush in at the hole, play over the surface of the pot, and go up the chimney. To prevent this the hole itself is made the chimney; but as this would be too short, and would produce very little current and very little heat, the whole furnace is set under a tall dome. Thus the heated air from the real furnace is confined in this dome, and constitutes a high column of very light air, which will therefore rise with great force up the dome, and escape at the top. The dome is therefore the chimney, and will produce a draught or current proportioned to its height. Some are raised above an hundred feet. When all the doors of this house are shut, and thus no supply given except through the fire, the current and heat become prodigious. This, however, cannot be done, because the workmen are in this chimney, and must have respirable air. But notwithstanding this supply by the house-doors, the draught of the real furnace is vastly increased by the dome, and a heat produced sufficient for the work, and which could not have been produced without the dome.

This has been applied with great ingenuity and effect to a furnace for melting iron from the ore, and an iron finery, both without a blast. The common blast iron furnace is well known. It is a tall cone with the apex undermost. The ore and fluxes are thrown into this cone mixed intimately with the fuel till it is full, and the blast of most powerful bellows is directed into the bottom of this cone through a hole in the side. The air is thrown in with such force, that it makes its way through the mass of matter, kindles the fuel in its passage, and fluxes the materials, which then drop down into a receptacle below the blast-hole, and thus the passage for the air is kept unobstructed. It was thought impossible to produce or maintain this current without bellows; but Mr Cotterel, an ingenious founder, tried the effect of a tall dome placed over the mouth of the furnace, and though it was not half the height of many glasshouse domes it had the desired effect. Considerable difficulties, however, occurred; and he had not surmounted them all when he left the neighbourhood of Edinburgh, nor have we heard that he has yet brought the invention to perfection. It is extremely difficult to place the holes below, at which the air is to enter, at such a precise height as neither to be choked by the melted matter, nor to leave ore and stones below them unmelted; but the invention is very ingenious, and will be of immense service if it can be perfected; for in many places iron ore is to be found where water cannot be had for working a blast furnace.

The last application which we shall make of the currents produced by heating the air is to the freeing mines, ships, prisons, &c. from the damp and noxious vapours which frequently infest them.

As a drift or work is carried on in the mine, let a trunk of deal boards, about 6 or 8 inches square, be laid along the bottom of the drift, communicating with a trunk carried up in the corner of one of the shafts. Let the top of this last trunk open into the ash-pit of a small furnace, having a tall chimney. Let fire be kindled in the furnace; and when it is well heated, shut the fire-place and ash-pit doors. There being no other supply for the current produced in the chimney of this furnace,

Effects of
Air's pres-
sure.

370

Improve-
ment of
Mr Cotterel
rel for
melting
iron from
the ore.

371

Currents of
air applied
to free
mines,
ships, pri-
sons, &c.
of noxious
air.

As of furnaces, the air will flow into it from the trunk, and will bring along with it all the offensive vapours. This is the most effectual method yet found out. In the same manner may trunks be conducted into the ash-pit of a furnace from the cells of a prison or the wards of an hospital.

In the account which we have been giving of the management of air in furnaces and common fires, we have frequently mentioned the immediate application of air to the burning fuel as necessary for its combustion. This is a general fact. In order that any inflammable body may be really inflamed, and its combustible matter consumed and ashes produced, it is not enough that the body be made hot. A piece of charcoal inclosed in a box of iron may be kept red-hot for ever, without wasting its substance in the smallest degree. It is farther necessary that it be in contact with a particular species of air, which constitutes about $\frac{1}{4}$ ths of the air of the atmosphere, viz. the vital air of Lavoisier. It was called *emphyreal air* by Scheele, who first observed its indispensable use in maintaining fire: and it appears, that, in contributing to the combustion of an inflammable body, this air combines with some of its ingredients, and becomes fixed air, suffering the same change as by the breathing of animals. Combustion may therefore be considered as a solution of the inflammable body in air. This doctrine was first promulgated by the celebrated Dr Hooke in his *Micrographia*, published in 1660, and afterwards improved in his treatise on Lamps. It is now completely established, and considered as a new discovery. It is for this reason that in fire-places of all kinds we have directed the construction, so as to produce a close application of the air to the fuel. It is quite needless at this day to enter into the discussions which formerly occupied philosophers about the manner in which the pressure and elasticity of the air promoted combustion. Many experiments were made in the last century by the first members of the Royal Society, to discover the office of air in combustion. It was thought that the flame was extinguished in rare air for want of a pressure to keep it together; but this did not explain its extinction when the air was not renewed. These experiments are still retained in courses of experimental philosophy, as they are injudiciously styled; but they give little or no information, nor tend to the illustration of any pneumatical doctrine; they are therefore omitted in this place. In short, it is now fully established, that it is not a mechanical but a chemical phenomenon. We can only inform the chemist, that a candle will consume faster in the low countries than in the elevated regions of Quito and Gondar, because the air is nearly one half denser below, and will act proportionally faster in decomposing the candle.

We shall conclude this part of our subject with the explanation of a curious phenomenon observed in many places. Certain springs or fountains are observed to have periods of repletion and scantiness, or seem to ebb and flow at regular intervals; and some of these periods are of a complicated nature. Thus a well will have several returns of high and low water, the difference of which gradually increases to a maximum, and then diminishes, just as we observe in the ocean. A very ingenious and probable explanation of this has been given in N° 424. of the Philosophical Transactions, by Mr Atwell, as follows.

Vol. XV. Part I.

Let ABCD (fig. 63.) represent a cavern, into which water is brought by the subterraneous passage OT. Let it have an outlet MNP, of a crooked form, with its highest part N considerably raised above the bottom of the cavern, and thence sloping downwards into lower ground, and terminating in an open well at P. Let the dimensions of this canal be such that it will discharge much more water than is supplied by TO. All this is very natural, and may be very common. The effect of this arrangement will be a remitting spring at P: for when the cavern is filled higher than the point N, the canal MNP will act as a syphon; and, by the conditions assumed, it will discharge the water faster than TO supplies it; it will therefore run it dry, and then the spring at P will cease to furnish water. After some time the cavern will again be filled up to the height N, and the flow at P will recommence.

If, besides this supply, the well P also receive water from a constant source, we shall have a reciprocating spring.

The situation and dimensions of this syphon canal, and the supply of the feeder, may be such, that the efflux at P will be constant. If the supply increase in a certain degree, a reciprocation will be produced at P with very short intervals; if the supply diminishes considerably, we shall have another kind of reciprocation with great intervals and great differences of water.

If the cavern has another simple outlet R, new varieties will be produced in the spring P, and R will afford a curious spring. Let the mouth of R, by which the water enters it from the cavern, be lower than N, and let the supply of the feeding spring be no greater than R can discharge, we shall have a constant spring from R, and P will give no water. But suppose that the main feeder increases in winter or in rainy seasons, but not so much as will supply both P and R, the cavern will fill till the water gets over N, and R will be running all the while; but soon after P has begun to flow, and the water in the cavern sinks below R, the stream from R will stop. The cavern will be emptied by the syphon canal MNP, and then P will stop. The cavern will then begin to fill, and when near full R will give a little water, and soon after P will run and R stop as before, &c.

Defaguliers shows, Vol. II. p. 177, &c. in what manner a prodigious variety of periodical ebbs and flows may be produced by underground canals, which are extremely simple and probable.

We shall conclude this article with the descriptions of some pneumatical machines or engines which have not been particularly noticed under their names in the former volumes of this work.

Bellows are of most extensive and important use; and it will be of service to describe such as are of uncommon construction and great power, fit for the great operations in metallurgy.

It is not the impulsive force of the blast that is wanted in most cases, but merely the copious supply of air, to produce the rapid combustion of inflammable matter; and the service would be better performed in general if this could be done with moderate velocities, and an extended surface. What are called air-furnaces, where a considerable surface of inflammable matter is acted on at once by the current which the mere heat of

Pneumatic Engines.
Plate CCCC.

374 Account of some pneumatic engines.

Pneumatic
Engines.

the expended air has produced, are found more operative in proportion to the air expended than blast furnaces animated by bellows; and we doubt not but that the method proposed by Mr Cotterel (which we have already mentioned) of increasing this current in a melting furnace by means of a dome, will in time supersede the blast furnaces. There is indeed a great impulsive force required in some cases; as for blowing off the scoriæ from the surface of silver or copper in refining furnaces, or for keeping a clear passage for the air in the great iron furnace.

In general, however, we cannot procure this abundant supply of air any other way than by giving it a great velocity by means of a great pressure, so that the general construction of bellows is pretty much the same in all kinds. The air is admitted into a very large cavity, and then expelled from it through a small hole.

The furnaces at the mines having been greatly enlarged; it was necessary to enlarge the bellows also: and the leathern bellows becoming exceedingly expensive, wooden ones were substituted in Germany about the beginning of last century, and from them became general through Europe. They consist of a wooden box ABCPFE (fig. 74. A), which has its top and two sides flat or straight, and the end BAE formed into an arched or cylindrical surface, of which the line FP at the other end is the axis. This box is open below, and receives within it the shallow box KHGNML (fig. B), which exactly fills it. The line FP of the one coincides with FP of the other, and along this line is a set of hinges on which the upper box turns as it rises and sinks. The lower box is made fast to a frame fixed in the ground. A pipe OQ proceeds from the end of it, and terminates at the furnace, where it ends in a small pipe called the *teuer* or *tuyere*. This lower box is open above, and has in its bottom two large valves V, V, opening inwards. The conducting pipe is sometimes furnished with a valve opening outwards, to prevent burning coals from being sucked into the bellows when the upper box is drawn up. The joint along PF is made tight by thin leather nailed along it. The sides and ends of the fixed box are made to fit the sides and curved end of the upper box, so that this last can be raised and lowered round the joint FP without sensible friction, and yet without suffering much air to escape: but as this would not be sufficiently air-tight by reason of the shrinking and warping of the wood, a farther contrivance is adopted. A slender lath of wood, divided into several joints, and covered on the outer edge with very soft leather, is laid along the upper edges of the sides and ends of the lower box. This lath is so broad, that when its inner edge is even with the inside of the box, its outer edge projects about an inch. It is kept in this position by a number of steel wires, which are driven into the bottom of the box, and stand up touching the sides, as represented in figure D, where *abc* are the wires, and *e* the lath, projecting over the outside of the box. By this contrivance the laths are pressed close to the sides and curved end of the moveable box, and the spring wires yield to all their inequalities. A bar of wood RS is fixed to the upper board, by which it is either raised by machinery, to sink again by its own weight, having an additional load laid on it, or it is forced downward by a crank or wiper of the machinery, and afterwards raised.

Plate
CCUCVI.

The operation here is precisely similar to that of blowing with a chamber-bellows. When the board is lifted up, the air enters by the valves V, V, and is expelled at the pipe OQ by depressing the boards. There is therefore no occasion to insist on this point.

These bellows are made of a very great size, AD being 16 feet, AB five feet, and the circular end AE also five feet. The rise, however, is but about 3 or 3½ feet. They expel at each stroke about 90 cubic feet of air, and they make about 8 strokes per minute.

Such are the bellows in general use on the continent. We have adopted a different form in this kingdom, which seems much preferable. We use an iron or wooden cylinder, with a piston sliding along it. This may be made with much greater accuracy than the wooden boxes, at less expence, if of wood, because it may be of coopers work, held together by hoops; but the great advantage of this form is its being more easily made air-tight. The piston is surrounded with a broad strap of thick and soft leather, and it has around its edge a deep groove, in which is lodged a quantity of wool. This is called the packing or stuffing, and keeps the leather very closely applied to the inner surface of the cylinder. Iron cylinders may be very neatly bored and smoothed, so that the piston, even when very tight, will slide along it very smoothly. To promote this, a quantity of black lead is ground very fine with water, and a little of this is smeared on the inside of the cylinder from time to time.

The cylinder has a large valve, or sometimes two, in the bottom, by which the atmospheric air enters when the piston is drawn up. When the piston is thrust down, this air is expelled along a pipe of great diameter, which terminates in the furnace with a small orifice.

This is the simplest form of bellows which can be conceived. It differs in nothing but size from the bellows used by the rudest nations. The Chinese smiths have a bellows very similar, being a square pipe of wood ABCDE (fig. 75.), with a square board G which exactly fits it, moved by the handle FG. At the farther end is the blast pipe HK, and on each side of it a valve in the end of the square pipe, opening inwards. The piston is sufficiently tight for their purposes without any leathering.

The piston of this cylinder bellows is moved by machinery. In some blast engines the piston is simply raised by the machine, and then let go, and it descends by its own weight, and compresses the air below it to such a degree, that the velocity of efflux becomes constant, and the piston descends uniformly: for this purpose it must be loaded with a proper weight. This produces a very uniform blast, except at the very beginning, while the piston falls suddenly and compresses the air: but in most engines the piston rod is forced down the cylinder with a determined motion, by means of a beam, crank, or other contrivance. This gives a more unequal blast, because the motion of the piston is necessarily slow in the beginning and end of the stroke, and quicker in the middle.

But in all it is plain that the blast must be desultory. It ceases while the piston is rising; for this reason it is usual to have two cylinders, as it was formerly usual to have two bellows which worked alternately. Sometimes three or four are used, as at the Carron iron works. This makes a blast abundantly uniform.

pneumatic
engines.
late
CXXVI.

But an uniform blast may be made with a single cylinder, by making it deliver its air into another cylinder, which has a piston exactly fitted to its bore, and loaded with a sufficient weight. The blowing cylinder ABCD (fig. 76.) has its piston P worked by a rod NP, connected by double chains with the arched head of the working beam NO, moving round a gudgeon at R. The other end O of this beam is connected by the rod OP, with the crank PQ of a wheel machine; or it may be connected with the piston of a steam engine, &c. &c. The blowing cylinder has a valve or valves E in its bottom, opening inwards. There proceeds from it a large pipe CF, which enters the regulating cylinder GHKI, and has a valve at top to prevent the air from getting back into the blowing cylinder. It is evident that the air forced into this cylinder must raise its piston L, and that it must afterwards descend, while the other piston is rising. It must descend uniformly, and make a perfectly equable blast.

Observe, that if the piston L be at the bottom when the machine begins to work, it will be at the bottom at the end of every stroke, if the *tuyere* T emits as much air as the cylinder ABCD furnishes; nay, it will lie a while at the bottom, for, while it was rising, air was issuing through T. This would make an interrupted blast. To prevent this, the orifice T must be lessened; but then there will be a surplus of air at the end of each stroke, and the piston L will rise continually, and at last get to the top, and allow air to escape. It is just possible to adjust circumstances, so that neither shall happen. This is done easier by putting a stop in the way of the piston, and putting a valve on the piston, or on the conducting pipe KST, loaded with a weight a little superior to the intended elasticity of the air in the cylinder. Therefore, when the piston is prevented by the stop from rising, the snifting valve, as it is called, is forced open, the superfluous air escapes, and the blast preserves its uniformity.

It may be of use to give the dimensions of a machine of this kind, which has worked for some years at a very great furnace, and given satisfaction.

The diameter of the blowing cylinder is 5 feet, and the length of the stroke is 6. Its piston is loaded with $3\frac{1}{2}$ tons. It is worked by a steam-engine whose cylinder is 3 feet 4 inches wide, with a six feet stroke. The regulating cylinder is 8 feet wide, and its piston is loaded with $8\frac{1}{2}$ tons, making about 2,63 pounds on the square inch; and it is very nearly in equilibrio with the load on the piston of the blowing cylinder. The conducting pipe KST is 12 inches in diameter, and the orifice of the *tuyere* was $1\frac{1}{2}$ inches when the engine was erected, but it has gradually enlarged by reason of the intense heat to which it is exposed. The snifting valve is loaded with 3 pounds on the square inch.

When the engine worked briskly, it made 18 strokes per minute, and there was always much air discharged by the snifting valve. When the engine made 15 strokes per minute, the snifting valve opened but seldom, so that things were nearly adjusted to this supply. Each stroke of the blowing cylinder sent in 118 cubic feet of common air. The ordinary pressure of the air being supposed $14\frac{1}{2}$ pounds on an inch, the density of the air in the regulating cylinder must be $\frac{14.75 + 2.63}{14.75} = 1.1783$, the natural density being 1.

This machine gives an opportunity of comparing the expence of air with the theory. It must (at the rate of 15 strokes) expel 30 cubic feet of air in a second through a hole of $1\frac{1}{4}$ inches in diameter. This gives a velocity of near 2000 feet per second; and of more than 1600 feet for the condensed air. This is vastly greater than the theory can give, or is indeed possible; for air does not rush into a void with so great velocity. It shows with great evidence, that a vast quantity of air must escape round the two pistons. Their united circumferences amount to above 40 feet, and they move in a dry cylinder. It is impossible to prevent a very great loss. Accordingly, a candle held near the edge of the piston L has its flame very much disturbed. This case, therefore, gives no hold for a calculation; and it suggests the propriety of attempting to diminish this great waste.

This has been very ingeniously done (in part at least) at some other furnaces. At Oneah foundry, near Glasgow, the blowing cylinder (also worked by a steam engine) delivers its air into a chest without a bottom, which is immersed in a large cistern of water, and supported at a small height from the bottom of the cistern, and has a pipe from its top leading to the *tuyere*. The water stands about five feet above the lower brim of the regulating air-chest, and by its pressure gives the most perfect uniformity of blast, without allowing a particle of air to get off by any other passage besides the *tuyere*. This is a very effectual regulator, and must produce a great saving of power, because a smaller blowing cylinder will thus supply the blast. We have not learned the dimensions and performance of this engine. We must observe, that the loss round the piston of the blowing cylinder remains undiminished.

A blowing machine was erected many years ago at Chastillon in France on a principle considerably different, and which must be perfectly air-tight throughout. Two cylinders A, B (fig. 77.), loaded with great weights, were suspended at the ends of the lever CD, moving round the gudgeon E. From the top F, G of each there was a large flexible pipe which united in H, from whence a pipe KT led to the *tuyere* T. There were valves at F and G opening outwards, or into the flexible pipes; and other valves L, M, adjoining to them in the top of each cylinder, opening inwards, but kept shut by a slight spring. Motion was given to the lever by a machine. The operation of this blowing machine is evident. When the cylinder A was pulled down, or allowed to descend, the water, entering at its bottom, compressed the air, and forced it along the passage FHKT. In the mean time, the cylinder B was rising, and the air entered by the valve M. We see that the blast will be very unequal, increasing as the cylinder is immersed deeper. It is needless to describe this machine more particularly, because we shall give an account of one which we think perfect in its kind, and which leaves hardly any thing to be desired in a machine of this sort. It was invented by Mr John Laurie, land-surveyor in Edinburgh, about 15 years ago, and improved in some respects since his death by an ingenious person of that city.

ABCD (fig. 78.) is an iron cylinder, truly bored within, and evasated a-top like a cup. EFGH is another, truly turned both without and within, and a small matter less than the inner diameter of the first cylinder.

X 2

Pneumatic
Engines.

Plate
CCCCVII.

This

Pneumatic
Engines.

This cylinder is close above, and hangs from the end of a lever moved by a machine. It is also loaded with weights at N. KILM is a third cylinder, whose outside diameter is somewhat less than the inside diameter of the second. This inner cylinder is fixed to the same bottom with the outer cylinder. The middle cylinder is loose, and can move up and down between the outer and inner cylinders without rubbing on either of them. The inner cylinder is perforated from top to bottom by three pipes OQ, SV, PR. The pipes OQ, PR have valves at their upper ends O, P, and communicate with the external air below. The pipe SV has a horizontal part VW, which again turns upwards, and has a valve at top X. This upright part WX is in the middle of a cistern of water *fbkg*. Into this cistern is fixed an air-chest *aYZb*, open below, and having at top a pipe *cde* terminating in the tuyere at the furnace.

When the machine is at rest, the valves X, O, P, are shut by their own weights, and the air-chest is full of water. When things are in this state, the middle cylinder EFGH is drawn up by the machinery till its lower brims F and G are equal with the top RM of the inner cylinder. Now pour in water or oil between the outer and middle cylinders: it will run down and fill the space between the outer and inner cylinders. Let it come to the top of the inner cylinder.

Now let the loaded middle cylinder descend. It cannot do this without compressing the air which is between its top and the top of the inner cylinder. This air being compressed will cause the water to descend between the inner and middle cylinders, and rise between the middle and outer cylinders, spreading into the cup; and as the middle cylinder advances downwards, the water will descend farther within it and rise farther without it. When it has got so far down, and the air has been so much compressed, that the difference between the surface of the water on the inside and outside of this cylinder is greater than the depth of water between X and the surface of the water *fg*, air will go out by the pipe SVW, and will lodge in the air-chest, and will remain there if *c* be shut, which we shall suppose for the present. Pushing down the middle cylinder till the partition touch the top of the inner cylinder, all the air which was formerly between them will be forced into the air-chest, and will drive out water from it. Draw up the middle cylinder, and the external air will open the valves O, P, and again fill the space between the middle and inner cylinders; for the valve X will shut, and prevent the regrefs of the condensed air. By pushing down the middle cylinder a second time, more air will be forced into the air-chest, and it will at last escape by getting out between its brims Y, Z and the bottom of the cistern; or if we open the passage *c*, it will pass along the conduit *cde* to the tuyere, and form a blast.

The operation of this machine is similar to Mr Haskins's quicksilver pump described by Defaguliers at the end of the second volume of his Experimental Philosophy. The force which condenses the air is the load on the middle cylinder. The use of the water between the inner and outer cylinders is to prevent this air from escaping; and the inner cylinder thus performs the office of a piston, having no friction. It is necessary that the length of the outer and middle cylinders be greater

than the depth of the regulator-cistern, that there may be a sufficient height for the water to rise between the middle and outer cylinders, to balance the compressed air, and oblige it to go into the air-chest. A large blast-furnace will require the regulator-cistern five feet deep, and the cylinders about six or seven feet long.

It is in fact a pump without friction, and is perfectly air-tight. The quickness of its operation depends on the small space between the middle cylinder and the two others; and this is the only use of these twp. Without these it would be similar to the engine at Chastillon, and operate more unequally and slowly. Its only imperfection is, that if the cylinder begin its motion of ascent or descent rapidly, as it will do when worked by a steam-engine, there will be some danger of water dashing over the top of the inner cylinder and getting into the pipe SV; but should this happen, an issue can easily be contrived for it at V, covered with a loaded valve *v*. This will never happen if the cylinder is moved by a crank.

One blowing cylinder only is represented here, but two may be used.

We do not hesitate in recommending this form of bellows as the most perfect of any, and fit for all uses where standing bellows are required. They will be cheaper than any other sort for common purposes. For a common smith's forge they may be made with square wooden boxes instead of cylinders. They are also easily repaired. They are perfectly tight; and they may be made with a blast almost perfectly uniform, by making the cistern in which the air-chest stands of considerable dimensions. When this is the case, the height of water, which regulates the blast, will vary very little.

This may suffice for an account of blast machines. The leading parts of their construction have been described as far only as was necessary for understanding their operation, and enabling an engineer to erect them in the most commodious manner. Views of complete machines might have amused, but they would not have added to our reader's information.

But the account is imperfect unless we show how their parts may be so proportioned that they shall perform what is expected from them. The engineer should know what size of bellows, and what load on the board or piston, and what size of tuyere, will give the blast which the service requires, and what force must be employed to give them the necessary degree of motion. We shall accomplish these purposes by considering the efflux of the compressed air through the tuyere. The propositions formerly delivered will enable us to ascertain this.

That we may proportion every thing to the power employed, we must recollect, that if the piston of a cylinder employed for expelling air be pressed down with any force *p*, it must be considered as superadded to the atmospheric pressure P on the same piston, in order that we may compare the velocity *v* of efflux with the known velocity V with which air rushes into a void. By what has been formerly delivered, it appears that this velocity

$$v = V \times \sqrt{\frac{p}{P + p}}$$
 where P is the pressure of the atmosphere on the piston, and *p* the additional load laid on it. This velocity is expressed in feet per second; and, when multiplied,

Pneumatic Engines. multiplied by the area of the orifice (also expressed in square feet), it will give us the cubical feet of condensed air expelled in a second: but the bellows are always to be filled again with common air, and therefore we want to know the quantity of common air which will be expelled; for it is this which determines the number of strokes which must be made in a minute, in order that the proper supply may be obtained. Therefore recollect that the quantity expelled from a given orifice with a given velocity, is in the proportion of the density; and that when D is the density of common air produced by the pressure P , the density d produced by the pressure $P + p$, is $D \times \frac{P+p}{P}$; or if D be made 1, we have $d = \frac{P+p}{P}$.

Therefore, calling the area of the orifice expressed in square feet O , and the quantity of common air, or the cubic feet expelled in a second Q , we have $Q = V \times O \times \sqrt{\frac{p}{P+p}} \times \frac{P+p}{P}$.

It will be sufficiently exact for all practical purposes to suppose P to be 15 pounds on every square inch of the piston; and p is then conveniently expressed by the pounds of additional load on every square inch: we may also take $V = 1332$ feet.

As the orifice through which the air is expelled is generally very small, never exceeding three inches in diameter, it will be more convenient to express it in square inches; which being the $\frac{1}{144}$ of a square foot, we shall have the cubic feet of common air expelled in a second.

or $Q = \frac{1332}{144} O \sqrt{\frac{p}{P+p}} \times \frac{P+p}{P} = O \times 9,25 \times \sqrt{\frac{p}{P+p}} \times \frac{P+p}{P}$; and this seems to be as simple an expression as we can obtain.

This will perhaps be illustrated by taking an example in numbers. Let the area of the piston be four square feet, and the area of the round hole through which the air is expelled be two inches, its diameter being 1,6, and let the load on the piston be 1728 pounds: this is three pounds on every square inch. We have $P = 15$, $p = 3$, $P + p = 18$, and $O = 2$; therefore we will have

$$Q = 2 \times 9,25 \times \sqrt{\frac{3}{18}} \times \frac{18}{15} = 9,053 \text{ cubic feet of common air expelled in a second.}$$

This will however be diminished at least one third by the contraction of the jet; and therefore the supply will not exceed six cubic feet per second. Supposing therefore that this blowing machine is a cylinder or prism of this dimension in its section, the piston so loaded would (after having compressed the air) descend about 15 inches in a second: It would first sink $\frac{1}{3}$ of the whole length of the cylinder pretty suddenly, till it had reduced the air to the density $\frac{2}{3}$, and would then descend uniformly at the above rate, expelling six cubic feet of common air in a second.

The computation is made much in the same way for bellows of the common form, with this additional circumstance, that as the loaded board moves round a hinge at one end, the pressure of the load must be calculated accordingly. The computation, however, becomes a little intricate, when the form of the loaded board is not rectangular: it is almost useless when the bellows

have flexible sides, either like smith's bellows or like organ bellows, because the change of figure during their motion makes continual variation on the compressing powers. It is therefore chiefly with respect to the great wooden bellows, of which the upper board slides down between the sides, that the above calculation is of service.

The propriety however of this piece of information is evident: we do not know precisely the quantity of air necessary for animating a furnace; but this calculation tells us what force must be employed for expelling the air that may be thought necessary. If we have fixed on the strength of the blast, and the diameter of the cylinder, we learn the weight with which the piston must be loaded; the length of the cylinder determines its capacity, the above calculation tells the expence per second; hence we have the time of the piston's coming to the bottom. This gives us the number of strokes per minute: the load must be lifted up by the machine this number of times, making the time of ascent precisely equal to that of descent; otherwise the machine will either catch and stop the descent of the piston, or allow it to lie inactive for a while of each stroke. These circumstances determine the labour to be performed by the machine, and it must be constructed accordingly. Thus the engineer will not be affronted by its failure, nor will he expend needless power and cost.

In machines which force the piston or bellows-board with a certain determined motion, different from what arises from their own weight, the computation is extremely intricate. When a piston moves by a crank, its motion at the beginning and end of each stroke is slow, and the compression and efflux is continually changing: we can however approximate to a statement of the force required.

Every time the piston is drawn up, a certain space of the cylinder is filled again with air of the common density; and this is expelled during the descent of the piston. A certain number of cubic feet of common air is therefore expelled with a velocity which perhaps continually varies; but there is a medium velocity with which it might have been uniformly expelled, and a pressure corresponding to this velocity. To find this, divide the area of the piston by the area of the blast-hole (or rather by this area multiplied by 0,613, in order to take in the effect of the contracted jet), and multiply the length of the stroke performed in a second by the quotient arising from this division; the product is the medium velocity of the air (of the natural density). Then find by calculation the height through which a heavy body must fall in order to acquire this velocity; this is the height of a column of homogeneous air which would expel it with this velocity. The weight of this column is the least force that can be exerted by the engine: but this force is too small to overcome the resistance in the middle of the stroke, and it is too great even for the end of the stroke, and much too great for the beginning of it. But if the machine is turned by a very heavy water-wheel, this will act as a regulator, accumulating in itself the superfluous force during the too favourable positions of the crank, and exerting it by its *vis insita* during the time of greatest effort. A force not greatly exceeding the weight of this column of air will therefore suffice. On the other hand, if the strength of the blast be determined, which is the general state of the problem, this determines

determines the degree of condensation of the air, and the load on the square inch of the piston, or the mean force which the machine must exert on it. A table, which will be given presently, determines the cubic feet of common air expelled in a second, corresponding to this load. This combined with the proposed dimensions of the cylinder, will give the descent of the piston or the length of the stroke.

These general observations apply to all forms of bellows; and without a knowledge of them no person can erect a machine for working them without total uncertainty or servile imitation. In order, therefore, that they may be useful to such as are not accustomed to the management of even these simple formulae, we insert the following short table of the velocity and quantity of air discharged from a cylinder whose piston is loaded with the pounds contained in the first column on every square inch. The second column contains the velocity with which the *condensed air* rushes out through any *small hole*; and the third column is the cubic feet discharged from a hole whose area is a square inch; column fourth contains the mean velocity of air of the common density; and column fifth is the cubic feet of common air discharged; the sixth column is the height in inches at which the force of the blast would support a column of water if a pipe were inserted into the side of the cylinder. This is an extremely proper addition to such machines, showing at all times the power of the machines, and teaching us what intensity of blast is employed for different purposes. The table is computed from the supposition that the ordinary pressure of the air is 15 pounds on a square inch. This is somewhat too great, and therefore the velocities are a little too small; but the quantities discharged will be found about $\frac{1}{3}$ too great (without affecting the velocities) on account of the convergency of the stream.

I	II	III	IV	V	VI
$\frac{1}{2}$	239	1,66	247	1,72	14
1	333	2,31	355	2,47	27
$1\frac{1}{2}$	404	2,79	437	3,05	40
2	457	3,17	518	3,60	54
$2\frac{1}{2}$	500	3,48	584	4,2	68
3	544	3,76	653	4,53	82
$3\frac{1}{2}$	582	4,03	715	4,98	95
4	611	4,24	774	5,38	109
$4\frac{1}{2}$	642	4,46	822	5,75	122
5	666	4,67	888	6,17	136
$5\frac{1}{2}$	693	4,84	950	6,49	150
6	711	5,06	997	6,92	163

This table extends far beyond the limits of ordinary use, very few blast-furnaces having a force exceeding 60 inches of water.

We shall conclude this account of blowing machines with a description of a small one for a blow-pipe. Fig. 79. ABCD, is a vessel containing water, about two feet deep. EFGH is the air-box of the blower open below, and having a pipe ILK rising up from it to a convenient height; an arm ON which grasps this pipe carries the lamp N: the blow-pipe LM comes from the top of the upright pipe. PKQ is the feeding pipe reaching near to the bottom of the vessel.

Water being poured into the vessel below, and its cover

being put on, which fits the upright pipe, and touches two studs *a, a*, projecting from it, blow in a quantity of air by the feeding pipe PQ; this expels the water from the air-box, and occasions a pressure which produces the blast through the blow-pipe M.

In n° 54. of this article, we mentioned an application which has been made of Hero's fountain, at Chemnitz in Hungary, for raising water from the bottom of a mine. We shall now give an account of this very ingenious contrivance.

In fig. 80. B represents the source of water elevated above the mouth of the pit 136 feet. From this there is led a pipe BCD four inches diameter. This pipe enters the top of a copper cylinder *bcd*, 8 $\frac{1}{2}$ feet high, five feet diameter, and two inches thick, and it reaches to within four inches of the bottom; it has a cock at C. This cylinder has a cock at F, and a very large one at E. From the top *bc* proceeds a pipe GHH' two inches in diameter, which goes down the pit 96 feet, and is inserted into the top of another brass cylinder *fgbi*, which is 6 $\frac{1}{2}$ feet high, four feet diameter, and two inches thick, containing 83 cubic feet, which is very nearly one half of the capacity of the other, viz. of 170 cubic feet. There is another pipe NI of four inches diameter, which rises from within four inches of the bottom of this lower cylinder, is folded into its top, and rises to the trough NO, which carries off the water from the mouth of the pit. This lower cylinder communicates at the bottom with the water L which collects in the drains of the mine. A large cock K serves to admit or exclude this water; another cock M, at the top of this cylinder, communicates with the external air.

Now suppose the cock C shut, and all the rest open; the upper cylinder will contain air, and the lower cylinder will be filled with water, because it is sunk so deep that its top is below the usual surface of the mine-waters. Now shut the cocks F, E, M, K, and open the cock C. The water of the source B must run in by the orifice D, and rise in the upper cylinder, compressing the air above it and along the pipe GHH', and thus acting on the surface of the water in the lower cylinder. It will therefore cause it to rise gradually in the pipe IN, where it will always be of such a height that its weight balances the elasticity of the compressed air. Suppose no issue given to the air from the upper cylinder, it would be compressed into $\frac{1}{3}$ th of its bulk by the column of 136 feet high; for a column of 34 feet nearly balances the ordinary elasticity of the air. Therefore, when there is an issue given to it through the pipe GHH', it will drive the compressed air along this pipe, and it will expel water from the lower cylinder. When the upper cylinder is full of water, there will be 34 cubic feet of water expelled from the lower cylinder. If the pipe IN had been more than 136 feet long, the water would have risen 136 feet, being then in equilibrio with the water in the feeding pipe BCD (as was shown in n° 52.), by the intervention of the elastic air; but no more water would have been expelled from the lower cylinder than what fills this pipe. But the pipe being only 96 feet high, the water will be thrown out at N with a very great velocity. If it were not for the great obstructions which water and air must meet with in their passage along pipes, it would issue at N with a velocity of more than 50 feet per second. It

issues

Pneumatic issues much more slowly, and at last the upper cylinder is full of water, and the water would enter the pipe GH and enter the lower cylinder, and without displacing the air in it, would rise through the discharging pipe IN, and run off to waste. To prevent this there hangs in the pipe HG a cork ball or double cone, by a brass wire which is guided by holes in two cross pieces in the pipe HG. When the upper cylinder is filled with water, this cork plugs up the orifice G, and no water is wasted; the influx at D now stops. But the lower cylinder contains compressed air, which would balance water in a discharging pipe 136 feet high, whereas IN is only 96. Therefore the water will continue to flow at N till the air has so far expanded as to balance only 96 feet of water, that is, till it occupies $\frac{1}{2}$ of its ordinary bulk, that is, $\frac{1}{2}$ of the capacity of the upper cylinder, or $42\frac{1}{2}$ cubic feet. Therefore $42\frac{1}{2}$ cubic feet will be expelled, and the efflux at N will cease; and the lower cylinder is about $\frac{1}{2}$ full of water. When the attending workman observes this, he shuts the cock C. He might have done this before, had he known when the orifice G was stopped; but no loss ensues from the delay. At the same time the attendant opens the cock E, the water issues with great violence, being pressed by the condensed air from the lower cylinder. It therefore issues with the sum of its own weight and of this compression. These gradually decrease together, by the efflux of the water and the expansion of the air; but this efflux stops before all the water has flowed out; for there is $42\frac{1}{2}$ feet of the lower cylinder occupied by air. This quantity of water remains, therefore, in the upper cylinder nearly: the workman knows this, because the discharged water is received first of all into a vessel containing $\frac{1}{2}$ of the capacity of the upper cylinder. Whenever this is filled, the attendant opens the cock K by a long rod which goes down the shaft; this allows the water of the mine to fill the lower cylinder, allows the air to get into the upper cylinder, and this allows the remaining water to run out of it.

And thus every thing is brought into its first condition; and when the attendant sees no more water come out at E, he shuts the cocks E and M, and opens the cock C, and the operation is repeated.

There is a very surprising appearance in the working of this engine. When the efflux at N has stopped, if the cock F be opened, the water and air rush out together with prodigious violence, and the drops of water are changed into hail or lumps of ice. It is a sight usually shown to strangers, who are desired to hold their hats to receive the blast of air: the ice comes out with such violence as frequently to pierce the hat like a pistol bullet. This rapid congelation is a remarkable instance of the general fact, that air by suddenly expanding, generates cold, its capacity for heat being increased. Thus the peasant cooks his broth by blowing over the spoon, even from warm lungs: a stream of air from a pipe is always cooling.

The above account of the procedure in working this engine shows that the efflux both at N and E becomes very slow near the end. It is found convenient therefore not to wait for the complete discharges, but to turn the cocks when about 30 cubic feet of water have been discharged at N: more work is done in this way. A gentleman of great accuracy and knowledge of these subjects

took the trouble, at our desire, of noticing particularly the performance of the machine. He observed that each stroke, as it may be called, took up about three minutes and $\frac{1}{2}$; and that 32 cubic feet of water were discharged at N, and 66 were expended at E. The expence therefore is 66 feet of water falling 136 feet, and the performance is 32 raised 96, and they are in the proportion of 66×136 to 32×96 , or of 1 to 0,1422, or nearly as 3 to 1. This is superior to the performance of the most perfect undershot mill, even when all friction and irregular obstructions are neglected; and is not much inferior to any overshot pump-mill that has yet been erected. When we reflect on the great obstructions which water meets with in its passage through long pipes, we may be assured that, by doubling the size of the feeder and discharger, the performance of the machine will be greatly improved; we do not hesitate to say, that it would be increased $\frac{1}{2}$: it is true that it will expend more water; but this will not be nearly in the same proportion; for most of the deficiency of the machine arises from the needless velocity of the first efflux at N. The discharging pipe ought to be 110 feet high, and not give sensibly less water.

Then it must be considered how inferior in original expence this simple machine must be to a mill of any kind which would raise 10 cubic feet 96 feet high in a minute, and how small the repairs on it need be, when compared with a mill.

And, lastly, let it be noticed, that such a machine can be used where no mill whatever can be put in motion. A small stream of water, which would not move any kind of wheel, will here raise $\frac{1}{2}$ of its own quantity to the same height; working as fast as it is supplied.

For all these reasons, we think that the Hungarian machine eminently deserves the attention of mathematicians and engineers, to bring it to its utmost perfection, and into general use. There are situations where this kind of machine may be very useful. Thus, where the tide rises 17 feet, it may be used for compressing air to $\frac{1}{2}$ of its bulk; and a pipe leading from a very large vessel inverted in it, may be used for raising the water from a vessel of $\frac{1}{2}$ of its capacity 17 feet high; or if this vessel has only $\frac{1}{4}$ of the capacity of the large one set in the tide-way, two pipes may be led from it; one into the small vessel, and the other into an equal vessel 16 feet higher, which receives the water from the first. Thus $\frac{1}{4}$ of the water may be raised 34 feet, and a smaller quantity to a still greater height; and this with a kind of power that can hardly be applied in any other way. Machines of this kind are described by Schottus, Sturmius, Leupold, and other old writers; and they should not be forgotten, because opportunities may offer of making them highly useful. A gentleman's house in the country may thus be supplied with water by a machine that will cost little, and hardly go out of repair.

The last pneumatical engine which we shall speak of at present is the common fanners, used for winnowing grain, and for drawing air out of a room: and we have but few observations to make on them.

The wings of the fanners are inclosed in a cylinder or drum, whose circular sides have a large opening BDE (fig. 81.) round the centre, to admit the air. By turning the wings rapidly round, the air is hurried round along with them, and thus acquires a centrifugal tendency, by which it presses strongly on the outer rim of the drum: this

Pneumatic
Engines.

Pneumatic
Engines.

this is gradually detached from the circle as at KI, and terminated in a trunk IHGF, which goes off in a tangential direction: the air therefore is driven along this passage.

If the wings were disposed in planes passing through the axis C, the compression of the air by their anterior surface would give it some tendency to escape in every direction, and would obstruct in some degree the arrival of more air through the side-holes. They are therefore reclined a little backward, as represented in the figure. It may be shown that their best form would be that of a hyperbolic spiral *abc*; but the straight form approaches sufficiently near to the most perfect shape.

Much labour is lost, however, in carrying the air

round those parts of the drum where it cannot escape. The fanners would either draw or discharge almost twice as much air if an opening were made all round one side. This could be gradually contracted (where required for winnowing) by a surrounding cone, and thus directed against the falling grain: this has been verified by actual trial. When used for drawing air out of a room for ventilation, it would be much better to remove the outer side of the drum entirely, and let the air fly freely off on all sides; but the flat sides are necessary, in order to prevent the air from arriving at the fanners any other way but through the central holes, to which trunks should be fitted leading to the apartment which is to be ventilated.

Pneumatic
Engines.

P O C

Pneuma-
tosis
||
Pococke.

PNEUMATOSIS. See MEDICINE, n° 336.

PNEUMONIA. See MEDICINE, n° 183.

PNEUMONICS, in pharmacy, medicines proper in diseases of the lungs, in which respiration is affected.

PO, a large and celebrated river of Italy, which has its source at mount Vifs in Piedmont, and on the confines of Dauphiny. It runs through Piedmont, Montferrat, the Milanese, and duchy of Mantua; from thence it runs to the borders of the Parmezan, and a part of the Modenese; and having entered the Ferarese, it begins to divide at Fichenuolo, and proceeds to discharge itself into the Gulf of Venice by four principal mouths. As it passes along, it receives several rivers, and often overflows its banks, doing a great deal of mischief: the reason of which is, that most of those rivers descend from the Alps, and are increased by the melting of the snow.

PQA, MEADOW-GRASS: A genus of the digynia order, belonging to the pentandria class of plants; and in the natural method ranking under the fourth order, *Gramina*. The calyx is bivalved and multiflorous; the spicula or partial spike is ovate, with the valvules scarious and a little sharp, or thin on the margin. There are 20 species; most of them grasses, and very agreeable food for cattle; for one species, which grows in marshes, the cattle will frequently go so deep as to endanger their lives. This is called the *aquatica*, or *water reed-grass*. It is the largest of the British grasses, growing to the height of five or six feet. The leaves are smooth, and half an inch wide or more. The panicle is eight or ten inches long, greatly branched, and decked with numerous spicula: these are of a reddish brown colour intermixed with green, of a compressed lanceolate form, imbricated with about six flowers for the most part, but varying from five to ten.

POCHETTI. See BARBATELLI.

POCOCKE (Dr Edward), one of the most learned men in the oriental tongues in Europe, was the eldest son of the Rev. Edward Pococke; and was born at Oxford in 1604, where he was also bred. In 1628 he was admitted probationer-fellow of his college, and about the same time had prepared an edition of the Second Epistle of St Peter, the Second and Third of St John, and that of St Jude, in Syriac and Greek, with a Latin Translation and Notes. In 1629 he was ordained priest, and appointed chaplain to the English merchants at Aleppo, where he continued five or six

P O D

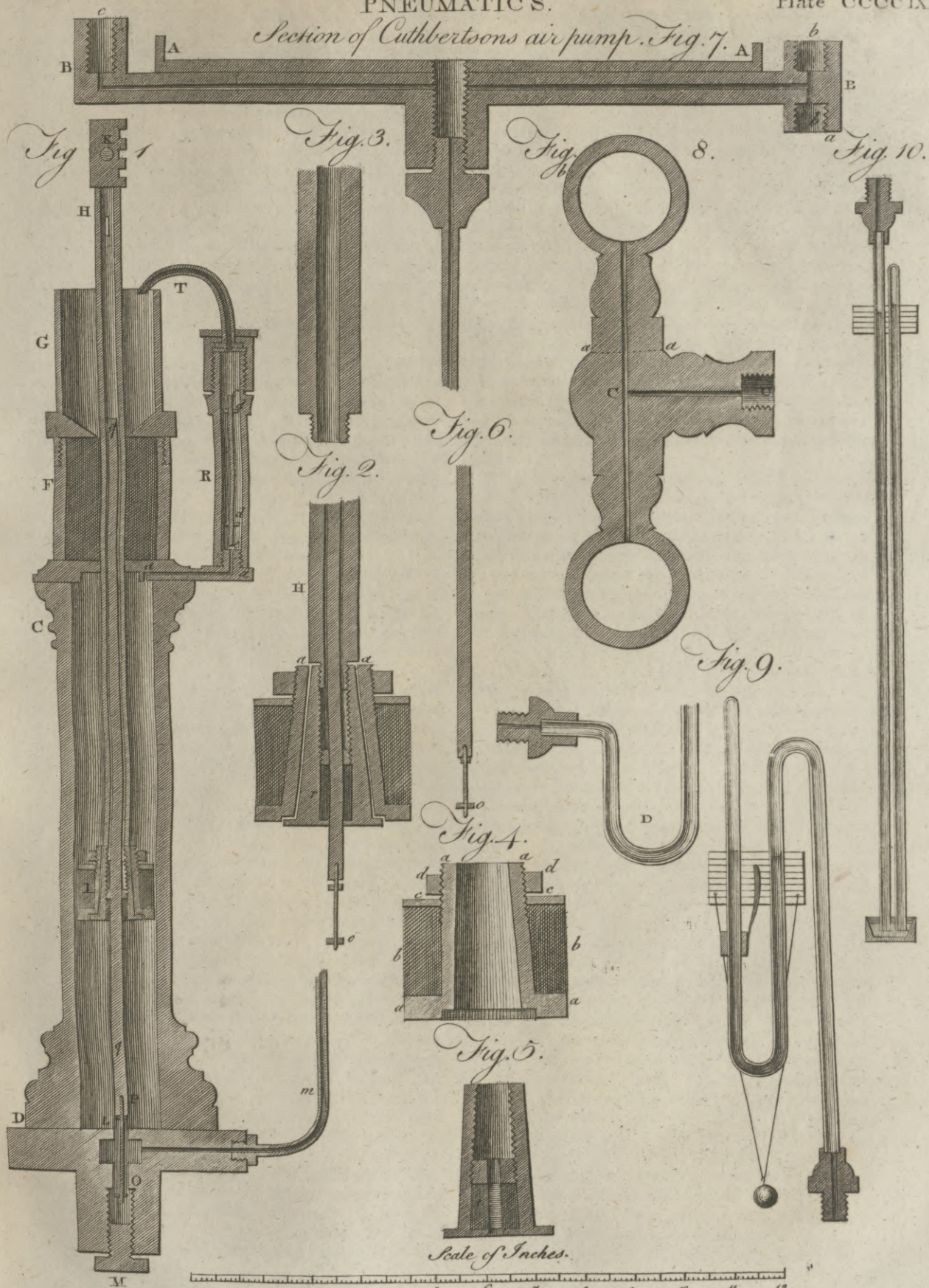
years; in which time he distinguished himself by his fortitude and zeal while the plague raged there. At length returning to England, he was in 1636 appointed reader of the Arabic lectures founded by archbishop Laud. Three years after he went to Constantinople, where he prosecuted his studies of the eastern tongues, and procured many valuable manuscripts. After near four years stay in that city, he embarked in 1640; and taking Paris in his way, visited Gabriel Sionita the famous Maronite, and Hugo Grotius. In 1643 he was presented to the rectory of Childrey in Berks; and about three years after married the daughter of Thomas Burdett, Esq. About the middle of 1647 he obtained the restitution of the salary of his Arabic lecture, which had been detained from him about three years. In 1648 king Charles I. who was then prisoner in the Isle of Wight, nominated Mr Pococke to the professorship of Hebrew, and the canonry of Christ-church annexed to it; but in 1650 he was ejected from his canonry for refusing to take the engagement, and soon after a vote passed for depriving him of his Hebrew and Arabic lectures; but several governors of houses, &c. presenting a petition in his favour, was suffered to enjoy both these places. He had some years before published his *Specimen Historiæ Arabum*; and now appeared his *Porta Mosæ*: and soon after the English Polyglot edition of the Bible, to which he had largely contributed, and also Eutychius's Annals, with a Latin version. At the Restoration, he was restored to the canonry of Christ-church, and also received the degree of doctor of divinity. He then published his Arabic version of Grotius's Treatise of the Truth of the Christian Religion; and an Arabic poem intitled *Lamiato'l Ajam*, with a Latin translation and notes. Soon after he published Gregory Abul Pharajius's *Historia Dynastiarum*. In 1674 he published an Arabic version of the chief parts of the Liturgy of the Church of England; and a few years after his Commentary on the Prophecies of Micah, Malachi, Hosea, and Joel. This great man died in 1691, after having been for many years confessedly the first person in Europe for eastern learning; and was no less worthy of admiration for his uncommon modesty and humility, and all the virtues that can adorn a Christian. His theological works were republished at London in 1740, in two volumes in folio.

PODAGRA, or the Gout. See MEDICINE, n° 211.

Pococke,
Podagra.

PODALIRIUS,

Section of Cuthbertsons air pump. Fig. 7. A



Scale of Inches.

Podalirius
||
e-bird.

PODALIRIUS, son of *Æsculapius* and *Epione*, was one of the pupils of the Centaur *Chiron*, under whom he made himself such a master of medicine, that during the Trojan war the Greeks invited him to their camp to stop a pestilence which had baffled the skill of all their physicians. Some suppose, however, that he went to the Trojan war, not in the capacity of a physician in the Grecian army, but as a warrior, attended by his brother *Machaon*, in 30 ships, with soldiers from *Æchalia*, *Ithome*, and *Trica*. At his return *Podalirius* was shipwrecked on the coast of *Caria*, where he cured of the falling sickness a daughter of the king of the place. He fixed his habitation there; and built two towns, one of which he called *Syrna*, after his wife. The *Carians*, on his death, built him a temple, and paid him divine honours.

PODEX, in anatomy, the same with **ANUS**.

PODGRAJE. See **ASISIA**.

PODOLIA, a province of Poland, bounded on the east by *Volhinia* and the river *Ukrain*; on the north and north-east, by *Budfiac Tartary*; on the south-east, by the river *Niester*, which separates it from *Bessarabia* and *Moldavia* in European Turkey on the south-west; and by the province of *Red Russia* on the north-west. It is usually divided into the Upper and Lower. In the Upper, which is the western part, the chief town is *Kamieck*, the capital of *Podolia*, and of a palatinate. In the Lower, or eastern part of *Podolia*, the chief town is *Bracklaw*, the capital of a palatinate.

PODOPHYLLUM, in botany: A genus of the monogynia order, belonging to the polyandria class of plants; and in the natural method ranking under the 27th order, *Rheada*. The corolla has nine petals; the calyx triphyllous; the berry unilocular, crowned with the stigma.

PODURA, or **SPRING TAIL**, in zoology, a genus of insects of the order of aptera. *Linn. Syst. Nat.* p. 1013. They have six feet formed for running; two eyes composed of eight facets; a tail forked, bent under the body, elastic, and acting like a spring; the antennæ are long and setaceous. "This genus is distinguished (says *Barbut*) into several species. Some inhabit still waters, leaping and walking with ease on the surface of that element. They assemble in troops in the morning, on the banks of pools, fish-ponds, and reservoirs; others are found in damp places, under leaves, bark, and stones; others among heaps of rotten wood, mushrooms, and in melon-beds. In Lapland, they are seen running upon the snow, but when it begins to melt they perish. The podura, by its elasticity, eludes the eager grasp of the naturalist. Its hard forky tail is a kind of spring, by means of which the body of the animal is thrown up into the air." The podura villosa is one of the largest species found in Britain, and appears to be of a brown footy colour, though it is really of a yellow brown, interspersed throughout with black-coloured spots and streaks. The head and thorax are hairy, and tickle to the fingers when touched; the abdomen is smooth: the antennæ, consisting of four articulations, are as long as two-thirds of the body. It is commonly found under stones.

POE-BIRD, in ornithology, is an inhabitant of some of the South Sea islands, where it is held in great esteem and veneration by the natives. It goes by the name of *kogo* in New Zealand; but it is better known by that of *poi-bird*. It is somewhat less than our blackbird. The

VOL. XV. Part I.

feathers are of a fine mazarine blue, except those of its neck, which are of a most beautiful silver grey, and two or three short white ones which are on the pinion-joint of the wing. Under its throat hang two little tufts of curled snow-white feathers, called its *poies* (the Otaheitian word for ear-rings); which occasioned the name of *poi-bird* being given to it. It is remarkable for the sweetness of its note, as well as the beauty of its plumage. Its flesh is also delicate food.

PÆCILE was a famous portico at Athens, which received its name from the variety (*ποικίλος*) of paintings which it contained. Zeno kept his school there; and there also the stoics received their lessons, whence their name, *à σοῶ, a porch*. The Pæcile was adorned, among many others, with a picture of the siege and sacking of Troy, the battle of Theseus against the Amazons, and the fight between the Lacedæmonians and Athenians at *Cenoe* in Argolis. The only reward which Miltiades obtained after the battle of Marathon was to have his picture drawn more conspicuous than that of the rest of the officers that fought with him, in the representation which was made of the engagement, and which was hung up in the Pæcile in commemoration of that celebrated victory.

POEM, a poetical composition. See **POETRY**.

POESTUM, or **POSIDONIA**, an ancient city of *Grecia Magna*, now part of the kingdom of Naples. It was founded by one of those colonies from Greece which in the early ages established themselves in Italy; and it flourished before the foundation of Rome itself. It was destroyed by the Goths on the decline of the Roman empire, who in their barbarous zeal for the Christian religion overturned every place of Pagan worship which was exposed to their ravages. Since that time it has been in ruins; and these ruins were unknown till they were discovered in the following manner: "In the year 1755 (says the author of the *Antiquities, History, and Views of Poestum*), an apprentice to a painter at Naples, who was on a visit to his friends at Capaccio, by accident took a walk to the mountains which surround the territory of Poestum. The only habitation he perceived was the cottage of a farmer, who cultivated the best part of the ground, and reserved the rest for pasture. The ruins of the ancient city made a part of this view, and particularly struck the eyes of the young painter; who, approaching nearer, saw with astonishment walls, towers, gates, and temples. Upon his return to Capaccio, he consulted the neighbouring people about the origin of these monuments of antiquity. He could only learn, that this part of the country had been uncultivated and abandoned during their memory; that about ten years before, the farmer, whose habitation he had noticed, established himself there; and that having dug in many places and searched among the ruins that lay round him, he had found treasures sufficient to enable him to purchase the whole. At the painter's return to Naples, he informed his master of these particulars, whose curiosity was so greatly excited by the description, that he took a journey to the place, and made drawings of the principal views. These were shown to the king of Naples, who ordered the ruins to be cleared, and Poestum arose from the obscurity in which it had remained for upwards of 700 years, as little known to the neighbouring inhabitants as to travellers."

Our author gives the following description of it in

Pæcile
||
Poestum.

Poetum.

its present state. It is, says he, of an oblong figure, about two miles and a half in circumference. It has four gates, which are opposite to each other. On the key-stone of the arch of the north gate, on the outside, is the figure of Neptune in basso relievo, and within a hippocampus. The walls which still remain are composed of very large cubical stones, and are extremely thick, in some parts 18 feet. That the walls have remained unto this time is owing to the very exact manner in which the stones are fitted to one another (a circumstance observed universally in the masonry of the ancients), and perhaps in some measure to a stalaetical concretion which has grown over them. On the walls here and there are placed towers of different heights; those near the gates being much higher and larger than the others, and evidently of modern workmanship. He observes, that, from its situation among marshes, bituminous and sulphureous springs, Poetum must have been unwholesome; a circumstance mentioned by Strabo, *Morbosam eam facit furvus in paludes diffusus*. In such a situation the water must have been bad. Hence the inhabitants were obliged to convey that necessary of life from purer springs by means of aqueducts, of which many vestiges still remain.

The principal monuments of antiquity are a theatre, an amphitheatre, and three temples. The theatre and amphitheatre are much ruined. The first temple is hexastylus, and amphiprostylos. At one end, the pilasters and two columns which divided the cella from the pronaos are still remaining. Within the cella are two rows of smaller columns, with an architrave, which support the second order. This temple our author takes to be

of that kind called by Vitruvius *hyphæthros*, and supports his opinion by a quotation from that author. The second temple is also amphiprostylos: it has nine columns in front and 18 in flank, and seems to be of that kind called by Vitruvius *pseudodipteros*. The third is likewise amphiprostylos. It has six columns in front and 13 in flank. Vitruvius calls this kind of temple *peripteros*. "The columns of these temples (says our author) are of that kind of Doric order which we find employed in works of the greatest antiquity. They are hardly five diameters in height. They are without bases, which also has been urged as a proof of their antiquity; but we do not find that the ancients ever used bases to this order, at least till very late. Vitruvius makes no mention of bases for this order: and the only instance we have of it is in the first order of the coliseum at Rome, which was built by Vespasian. The pillars of these temples are fluted with very shallow flutings in the manner described by Vitruvius. The columns diminish from the bottom, which was the most ancient method almost universally in all the orders. The columns have astragals of a very singular form; which shows the error of those who imagine that this member was first invented with the Ionic order, to which the Greeks gave an astragal, and that the Romans were the first who applied it to the Doric. The echinus of the capitol is of the same form with that of the temple of Corinth described by Le Roy." See *Swinburne's Travels in the Two Sicilies*, vol. ii. p. 131—140.

Poetum,
Poet.

POET, the author of a poem. See the article: POETRY.

Provençal Poets. See TROUBADOURS.

P O E T R Y.

1
Origin
of poetry.

AMIDST those thick clouds which envelope the first ages of the world, reason and history throw some lights on the origin and primitive employment of this divine art. Reason suggests, that before the invention of letters, all the people of the earth had no other method of transmitting to their descendants the principles of their worship, their religious ceremonies, their laws, and the renowned actions of their sages and heroes, than by poetry; which included all these objects in a kind of hymns that fathers sung to their children, in order to engrave them with indelible strokes in their hearts. History not only informs us, that Moses and Miriam, the first authors that are known to mankind, sung, on the borders of the Red Sea, a song of divine praise, to celebrate the deliverance which the Almighty had vouchsafed to the people of Israel, by opening a passage to them through the waters; but it has also transmitted to us the song itself, which is at once the most ancient monument and a master-piece of poetic composition.

The Greeks, a people the most ingenious, the most animated, and in every sense the most accomplished, that the world ever produced—strove to ravish from the Heavens the precious gift of poetry, which was vouchsafed them by the Supreme Author of all nature, that they might ascribe it to their false deities. According to their ingenious fictions, Apollo became the god of poetry, and dwelt on the hills of Phocis, Parnassus, and Helicon, whose feet were washed by the waters of Hypocrene, of which each mortal that ever drank was

seized with a sacred delirium. The immortal swans floated on its waves. Apollo was accompanied by the Muses—those nine learned sisters—the daughters of Memory: and he was constantly attended by the Graces. Pegasus, his winged courser, transported him with a rapid flight into all the regions of the universe. Happy emblems! by which we at this day embellish our poetry, as no one has ever yet been able to invent more brilliant images.

The literary annals of all nations afford vestiges of poetry from the remotest ages. They are found among the most savage of the ancient barbarians, and the most desolate of all the Americans. Nature asserts her rights in every country and every age. Tacitus mentions the verses and the hymns of the Germans, at the time when that rough people yet inhabited the woods, and while their manners were still savage. The first inhabitants of Runnia, and the other northern countries, those of Gaul, Albion, Iberia, Ausonia, and other nations of Europe, had their poetry, as well as the ancient people of Asia, and of the known borders of Africa. But the simple productions of nature have constantly something unformed, rough, and savage. The Divine Wisdom appears to have placed the ingenious and polished part of mankind on the earth, in order to refine that which comes from her bosom rude and imperfect: and thus art has polished poetry, which issued quite naked and savage from the brains of the first of mankind.

But what is Poetry? It would be to abridge the limits

introd.

2
fiction
of poetry.

limits of the poetic empire, to contract the sphere of this divine art, should we say, in imitation of all the dictionaries and other treatises on versification, That *poetry is the art of making verses, of lines or periods that are in rhyme or metre*. This is rather a grammatical explanation of the word, than a real definition of the thing, and it would be to degrade poetry thus to define it. The father of criticism has denominated poetry *τεχνη μιμητική, an imitative art*: but this, though just in itself, is too general for a definition, as it does not discriminate poetry from other arts which depend equally on imitation. The justest definition seems to be that given by Baron Bielfield *, *That poetry is the art of expressing our thoughts by fiction*. In fact, it is after this manner (if we reflect with attention) that all the metaphors and allegories, all the various kinds of fiction, form the first materials of a poetic edifice: it is thus that all images, all comparisons, allusions, and figures, especially those which personify moral subjects, as virtues and vices, concur to the decorating of such a structure. A work, therefore, that is filled with invention, that incessantly presents images which render the reader attentive and affected, where the author gives interesting sentiments to every thing that he makes speak, and where he makes speak by sensible figures all those objects which would affect the mind but weakly when clothed in a simple prosaic style, such a work is a poem. While that, though it be in verse, which is of a didactic, dogmatic, or moral nature, and where the objects are presented in a manner quite simple, without fiction, without images or ornaments, cannot be called *poetry*, but merely a work in verse; for the art of reducing thoughts, maxims, and periods, into rhyme or metre, is very different from the art of poetry.

Elem. of
iv. Erud.

An ingenious fable, a lively and interesting romance, a comedy, the sublime narrative of the actions of a hero, such as the *Telemachus* of M. Fenelon, though written in prose, but in measured prose, is therefore a work of poetry: because the foundation and the superstructure are the productions of genius, as the whole proceeds from fiction; and truth itself appears to have employed an innocent and agreeable deception to instruct with efficacy. This is so true, that the pencil also, in order to please and affect, has recourse to fiction; and this part of painting is called the *poetic composition of a picture*. It is therefore by the aid of fiction that poetry, so to

speak, paints its expressions, that it gives a body and a mind to its thoughts, that it animates and exalts that which would otherwise have remained arid and insensible. It is the peculiar privilege of poetry to exalt inanimate things into animals, and abstract ideas into persons. The former licence is so common, that it is now considered as nothing more than a characteristical dialect appropriated by the poets to distinguish themselves from the writers of prose; and it is at the same time so essential, that we question much if this species of composition could subsist without it: for it will perhaps, upon examination, be found, that in every poetical description some of the qualities of Animal Nature are ascribed to things not having life. Every work, therefore, where the thoughts are expressed by fictions or images, is poetic; and every work where they are expressed naturally, simply, and without ornament, although it be in verse, is prosaic.

Verse, however, is not to be regarded as foreign or superfluous to poetry. To reduce those images, those fictions, into verse, is one of the greatest difficulties in poetry, and one of the greatest merits in a poem: and for these reasons, the cadence, the harmony of sounds, particularly that of rhyme, delight the ear to a high degree, and the mind insensibly repeats them while the eye reads them. There results therefore a pleasure to the mind, and a strong attachment to these ornaments: but this pleasure would be frivolous, and even childish, if it were not attended by a real utility. Verses were³ invented in the first ages of the world, merely to³ aid and to strengthen the memory: for cadence, harmony, and especially rhyme, afford the greatest assistance to the memory that art can invent; and the images, or poetic fictions, that strike our senses, assist in grav-³ing them with such deep traces in our minds, as even time itself frequently cannot efface. How many excellent apophthegms, sentences, maxims, and precepts, would have been buried in the abyss of oblivion, if poetry had not preserved them by its harmony? To give more efficacy to this lively impression, the first poets sung their verses, and the words and phrases must necessarily have been reduced, at least to cadence, or they could not have been susceptible of musical expression. One of the great excellencies, therefore, though not a necessary constituent, of poetry, consists in its being expressed in verse. See Part III.

3
Verse, though not essential to poetry, one of its excellencies.

PART I. GENERAL PRINCIPLES OF THE ART.

SECT. I. Of the Essence and End of Poetry.

4
Essence of
poetry.

THE *essence* of *Polite Arts* in general, and consequently of poetry in particular, consists in *expression*; and we think that, to be poetic, the expression must necessarily arise from *fiction*, or invention. (See the article *ART*, particularly from n° 12. to the end.) This invention, which is the fruit of happy genius alone, arises, 1. From the subject itself of which we undertake to treat: 2. From the manner in which we treat that subject, or the species of writing of which we make use: 3. From the plan that we propose to follow in conformity to this manner; and, 4. From the method of executing this plan in its full detail. Our first guides, the ancients, afford us no lights that can elucidate all these objects in general. The precepts which Aristotle

lays down, relate to epic and dramatic poetry only; and which, by the way, confirms our idea, that antiquity itself made the essence of poetry to consist in fiction, and not in that species of verse which is destitute of it, or in that which is not capable of it. But since this art has arrived to a great degree of perfection; and as poetry, like electricity, communicates its fire to every thing it touches, and animates and embellishes whatever it treats; there seems to be no subject in the universe to which poetry cannot be applied, and which it cannot render equally brilliant and pleasing. From this universality of poetry, from its peculiar property of expression by fiction, which is applicable to all subjects, have arisen its different species, of which a particular description will be given in the *second* part.

Horace, in a well-known verse, has been supposed to

Y 2

declare

Of
Invention

declare the end of poetry to be twofold, to please, or to instruct :

Aut prodesse volunt, aut delectare poeta.

5
End of
poetry.

* *Essays on
Poetry and
Music,*
Part I.
chap. i.

But Dr Beattie * maintains, that the ultimate end of this art is to please ; instruction being only one of the means (and not always a necessary one) by which that ultimate end is to be accomplished. The passage rightly understood, he observes, will not appear to contain any thing inconsistent with this doctrine. The author is there stating a comparison between the Greek and Roman writers, with a view to the poetry of the stage ; and, after commending the former for their correctness, and for the liberal spirit wherewith they conducted their literary labours, and blaming his countrymen for their inaccuracy and avarice, he proceeds thus : “ The ends proposed by our dramatic poets (or by poets in general) are, to please, to instruct, or to do both. When instruction is your aim, let your moral sentences be expressed with brevity, that they may be readily understood, and long remembered : where you mean to please, let your fictions be conformable to truth, or probability. The elder part of your audience (or readers) have no relish for poems that give pleasure only without instruction ; nor the younger for such writings as give instruction without pleasure. He only can secure the universal suffrage in his favour, who blends the useful with the agreeable, and delights at the same time that he instructs the reader. Such are the works that bring money to the bookseller, that pass into foreign countries, and perpetuate the author’s name through a long succession of ages †.”—Now, what is the meaning of all this? What, but that to the perfection of dramatic poetry (or, if you please, of poetry in general) both sound morals and beautiful fiction are requisite? But Horace never meant to say, that instruction, as well as pleasure, is necessary to give to any composition the poetical character ; or he would not in another place have celebrated with so much affection and rapture the melting strains of Sappho, and the playful genius of Anacreon ‡.—two authors transcendently sweet, but not remarkably instructive. We are sure, that pathos, and harmony, and elevated language, were, in Horace’s opinion, essential to poetry § ; and of these decorations nobody will affirm that instruction is the end, who considers that the most instructive books in the world are written in plain prose.

In short, our author has endeavoured by many ingenious arguments and illustrations to establish it as a truth in criticism, that the end of poetry is to please. Verses, if pleasing, may be poetical, though they convey little or no instruction ; but verses, whose sole merit it is that they convey instruction, are not poetical. Instruction, however, he admits, especially in poems of length, is necessary to their perfection, because they would not be perfectly agreeable without it.

SECT. II. Of the Standard of Poetical Invention.

6
Poetical
invention
to be regulated
¶ *Iliad*, b. 8.
v. 555.

HOMER’s beautiful description of the heavens and earth, as they appear in a calm evening by the light of the moon and stars, concludes with this circumstance, “ And the heart of the shepherd is glad ¶.” Madame Dacier, from the turn she gives to the passage in her version, seems to think, and Pope, in order perhaps to

make out his couplet, insinuates, that the gladness of the shepherd is owing to his sense of the utility of those luminaries. And this may in part be the case : but this is not in Homer ; nor is it a necessary consideration. It is true, that, in contemplating the material universe, they who discern the causes and effects of things must be more rapturously entertained than those who perceive nothing but shape and size, colour and motion. Yet, in the mere outside of Nature’s work, there is a splendor and a magnificence to which even untutored minds cannot attend without great delight.

Not that all peasants or all philosophers are equally susceptible of these charming impressions. It is strange to observe the callousness of some men, before whom all the glories of heaven and earth pass in daily succession, without touching their hearts, elevating their fancy, or leaving any durable remembrance. Even of those who pretend to sensibility, how many are there to whom the lustre of the rising or setting sun ; the sparkling concave of the midnight-sky ; the mountain-forest tossing and roaring to the storm, or warbling with all the melodies of a summer-evening ; the sweet interchange of hill and dale, shade and sunshine, grove, lawn, and water, which an extensive landscape offers to the view ; the scenery of the ocean, so lovely, so majestic, and so tremendous ; and the many pleasing varieties of the animal and vegetable kingdoms, could never afford so much real satisfaction, as the steams and noise of a ball-room, the insipid fiddling and squeaking of an opera, or the vexations and wranglings of a card-table !

But some minds there are of a different make ; who, even in the early part of life, receive from the contemplation of Nature a species of delight which they would hardly exchange for any other, and who, as avarice and ambition are not the infirmities of that period, would, with equal sincerity and rapture, exclaim,

I care not, Fortune, what you me deny ;
You cannot rob me of free Nature’s grace ;
You cannot shut the windows of the sky,
Through which Aurora shows her bright’ning face ;
You cannot bar my constant feet to trace
The woods and lawns by living stream at eve.

Castle of Indolence.

Such minds have always in them the seeds of true taste, and frequently of imitative genius. At least, though their enthusiastic or visionary turn of mind (as the man of the world would call it) should not always incline them to practise poetry or painting, we need not scruple to affirm, that without some portion of this enthusiasm no person ever became a true poet or painter. For he who would imitate the works of nature, must first accurately observe them ; and accurate observation is to be expected from those only who take great pleasure in it.

To a mind thus disposed no part of creation is indifferent. In the crowded city and howling wilderness ; in the cultivated province and solitary isle ; in the flowery lawn and craggy mountain ; in the murmur of the rivulet and in the uproar of the ocean ; in the radiance of summer and gloom of winter ; in the thunder of heaven and in the whisper of the breeze ; he still finds something to rouse or to soothe his imagination, to draw forth his affections, or to employ his understanding. And from every mental energy that is not attended

Of
Invention.

Beattie’s
Essays,
Part I.
chap. ii.

attended with pain, and even from some of those that are, as moderate terror and pity, a sound mind derives satisfaction; exercise being equally necessary to the body and the soul, and to both equally productive of health and pleasure.

This happy sensibility to the beauties of nature should be cherished in young persons. It engages them to contemplate the Creator in his wonderful works; it purifies and harmonizes the soul, and prepares it for moral and intellectual discipline; it supplies an endless source of amusement; it contributes even to bodily health: and, as a strict analogy subsists between material and moral beauty, it leads the heart by an easy transition from the one to the other; and thus recommends virtue for its transcendent loveliness, and makes vice appear the object of contempt and abomination. An intimate acquaintance with the best descriptive poets, Spenser, Milton, and Thomson, but above all with the divine George, joined to some practice in the art of drawing, will promote this amiable sensibility in early years: for then the face of nature has novelty superadded to its other charms, the passions are not pre-engaged, the heart is free from care, and the imagination warm and romantic.

But not to insist longer on those ardent emotions that are peculiar to the enthusiastic disciple of nature, may it not be affirmed of all men, without exception, or at least of all the enlightened part of mankind, that they are gratified by the contemplation of things natural, as opposed to unnatural? Monstrous sights please but for a moment, if they please at all; for they derive their charm from the beholder's amazement, which is quickly over. We read indeed of a man of rank in Sicily*, who chooses to adorn his villa with pictures and statues of most unnatural deformity: but it is a singular instance; and one would not be much more surprised to hear of a person living without food, or growing fat by the use of poison. To say of any thing, that it is *contrary to nature*, denotes censure and disgust on the part of the speaker; as the epithet *natural* intimates an agreeable quality, and seems for the most part to imply, that a thing is as it ought to be, suitable to our own taste, and congenial with our own constitution. Think with what sentiments we should peruse a poem, in which nature was totally misrepresented, and principles of thought, and of operation supposed to take place, repugnant to every thing we had seen or heard of:—in which, for example, avarice and coldness were ascribed to youth, and prodigality and passionate attachment to the old; in which men were made to act at random, sometimes according to character, and sometimes contrary to it; in which cruelty and envy were productive of love, and beneficence and kind affection of hatred; in which beauty was invariably the object of dislike, and ugliness of desire; in which society was rendered happy by atheism and the promiscuous perpetration of crimes, and justice and fortitude were held in universal contempt. Or think, how we should relish a painting, where no regard was had to the proportions, colours, or any of the physical laws, of Nature:—where the ears and eyes of animals were placed in their shoulders; where the sky was green and the grass crimson; where trees grew with their branches in the earth and their roots in the air; where men were seen fighting after their heads were cut off, ships sailing on the land, lions entangled in cob-

webs, sheep preying on dead carcases, fishes sporting in the woods, and elephants walking on the sea. Could such figures and combinations give pleasure, or merit the appellation of sublime or beautiful? Should we hesitate to pronounce their author mad? And are the absurdities of madmen proper subjects either of amusement or of imitation to reasonable beings?

Let it be remarked, too, that though we distinguish our internal powers by different names, because otherwise we could not speak of them so as to be understood, they are all but so many energies of the same individual mind; and therefore it is not to be supposed, that what contradicts any one leading faculty should yield permanent delight to the rest. That cannot be agreeable to reason, which conscience disapproves; nor can that gratify imagination, which is repugnant to reason.— Besides, belief and acquiescence of mind are pleasant, as distrust and disbelief are painful: and therefore, that only can give solid and general satisfaction, which has something of plausibility in it; something which we conceive it possible for a rational being to believe. But no rational being can acquiesce in what is obviously contrary to nature, or implies palpable absurdity.

Poetry, therefore, and indeed every art whose end is to please, must be natural; and if so, must exhibit real matter of fact, or something like it; that is, in other words, must be either according to truth or according to verisimilitude.

And tho' every part of the material universe abounds in objects of pleasurable contemplation, yet nothing in nature so powerfully touches our hearts, or gives so great variety of exercise to our moral and intellectual faculties, as man. Human affairs and human feelings are universally interesting. There are many who have no great relish for the poetry that delineates only irrational or inanimate beings; but to that which exhibits the fortunes, the characters, and the conduct of men, there is hardly any person who does not listen with sympathy and delight. And hence, to imitate human action, is considered by Aristotle as essential to this art; and must be allowed to be essential to the most pleasing and most instructive part of it, Epic and Dramatic composition. Mere descriptions, however beautiful, and moral reflections, however just, become tiresome, where our passions are not occasionally awakened by some event that concerns our fellow-men. Do not all readers of taste receive peculiar pleasure from those little tales or episodes with which Thomson's descriptive poem on the Seasons is here and there enlivened? and are they not sensible, that the thunder-storm would not have been half so interesting without the tale of the two lovers (*Summ.* v. 1171); nor the harvest-scene, without that of Palemon and Lavinia (*Aut.* v. 177.); nor the driving snows, without that exquisite picture of a man perishing among them (*Winter.* v. 276.)? It is much to be regretted, that Young did not employ the same artifice to animate his Night-Thoughts. Sentiments and descriptions may be regarded as the pilasters, carvings, gildings, and other decorations of the poetical fabric: but human actions are the columns and the rafters that give it stability and elevation. Or, changing the metaphor, we may consider these as the soul which informs the lovely frame; while those are little more than the ornaments of the body.

Whether the pleasure we take in things natural, and

8
Habit has
great in-
fluence
over senti-
ment and
feeling, and
of course
upon
poetry.

our dislike to what is the reverse, be the effect of habit or of constitution, is not a material inquiry. There is nothing absurd in supposing, that between the soul, in its first formation, and the rest of nature, a mutual harmony and sympathy may have been established, which experience may indeed confirm, but no perverse habits could entirely subdue. As no sort of education could make man believe the contrary of a self-evident axiom, or reconcile him to a life of perfect solitude; so we should imagine, that our love of nature and regularity might still remain with us in some degree, though we had been born and bred in the Sicilian villa above-mentioned, and never heard any thing applauded but what deserved censure, nor censured but what merited applause. Yet habit must be allowed to have a powerful influence over the sentiments and feelings of mankind: for objects to which we have been long accustomed, we are apt to contract a fondness: we conceive them readily, and contemplate them with pleasure; nor do we quit our old tracts of speculation or practice without reluctance and pain. Hence in part arises our attachment to our own professions, our old acquaintance, our native soil, our homes, and to the very hills, streams, and rocks in our neighbourhood. It would therefore be strange, if man, accustomed as he is from his earliest days to the regularity of nature, did not contract a liking to her productions and principles of operation.

9
No neces-
sity that
the poet
should ex-
actly copy
nature.

Yet we neither expect nor desire, that every human invention, where the end is only to please, should be an exact transcript of real existence. It is enough, that the mind acquiesce in it as probable or plausible, or such as we think might happen without any direct opposition to the laws of nature:—Or, to speak more accurately, it is enough that it be consistent, either, first, with general experience; or, secondly, with popular opinion; or, thirdly, that it be consistent with itself, and connected with probable circumstances.

First: If a human invention be consistent with *general* experience, we acquiesce in it as sufficiently probable. *Particular* experiences, however, there may be, so uncommon, and so little expected, that we should not admit their probability, if we did not know them to be true. No man of sense believes, that he has any likelihood of being enriched by the discovery of hidden treasure; or thinks it probable, on purchasing a lottery-ticket, that he shall gain the first prize: and yet great wealth has actually been acquired by such good fortune. But we should look upon these as poor expedients in a play or romance for bringing about a happy catastrophe. We expect that fiction should be more consonant to the general tenor of human affairs; in a word, that not possibility, but probability, should be the standard of poetical invention.

10
Fiction suf-
ficiently
conform-
able to
nature
when it ac-
cords with
received
opinions,

Secondly: Fiction is admitted as conformable to this standard, when it accords with received opinions. These may be erroneous, but are not often *apparently* repugnant to nature. On this account, and because they are familiar to us from our infancy, the mind readily ac-

quiesces in them, or at least yields them that degree of credit which is necessary to render them pleasing: hence the fairies, ghosts, and witches of Shakespeare, are admitted as probable beings; and angels obtain a place in religious pictures though we know that they do not now appear in the scenery of real life. A poet who should at this day make the whole action of his tragedy depend upon enchantment, and produce the chief events by the assistance of supernatural agents, would indeed be censured as transgressing the bounds of probability, be banished from the theatre to the nursery, and condemned to write fairy tales instead of tragedies. But Shakespeare was in no danger of such censures: In his days the doctrine of witchcraft was established both by law and by the fashion; and it was not only unpolite, but criminal, to doubt it. Now indeed it is admitted only by the vulgar; but it does not therefore follow that an old poem built upon it should not be acceptable to the learned themselves. When a popular opinion has long been exploded, and has become repugnant to philosophical belief, the fictions built upon it are still admitted as natural, both because we all remember to have listened to them in childhood with some degree of credit, and because we know that they were accounted natural by the people to whom they were first addressed; whose sentiments and views of things we are willing to adopt, when, by the power of pleasing description, we are introduced into their scenes, and made acquainted with their manners. Hence we admit the theology of the ancient poets, their Elysium and Tartarus, Scylla and Charybdis, Cyclops and Circe, and the rest of those “beautiful wonders” (as Horace calls them) which were believed in the heroic ages; as well as the demons and enchantments of Tasso, which may be supposed to have obtained no small degree of credit among the Italians of the 16th century, and are suitable enough to the notions that prevailed universally in Europe not long before (A). In fact, when poetry is in other respects true, when it gives an accurate display of those parts of nature about which we know that men in all ages must have entertained the same opinion, namely, those appearances in the visible creation, and those feelings and workings of the human mind, which are obvious to all mankind;—when poetry is thus far according to nature, we are very willing to be indulgent to what is fictitious in it, and to grant a temporary allowance to any system of fable which the author pleases to adopt; provided that he lay the scene in a distant country, or fix the date to a remote period. This is no unreasonable piece of complaisance; we owe it both to the poet and to ourselves; for without it we should neither form a right estimate of his genius, nor receive from his works that pleasure which they were intended to impart. Let him, however, take care, that his system of fable be such as his countrymen and cotemporaries (to whom his work is immediately addressed) might be supposed capable of yielding their assent to; for otherwise we should not believe him to be in earnest: and let him connect it as much

(A) In the 14th century, the common people of Italy believed, that the poet Dante went down to hell; that the *Inferno* was a true account of what he saw there; and that his fallow complexion, and stunted beard (which seemed by its growth and colour to have been too near the fire), were the consequence of his passing so much of his time in that hot and smoky region. See *Vicende della Letteratura del Sig. G. Denina*, cap. 4.

Inv. tion.

much as he can with probable circumstances, and make it appear in a series of events consistent with itself.

For (thirdly) if this be the case, we shall admit his story as probable, or at least as natural, and consequently be interested in it, even though it be not warranted by general experience, and derive but slender authority from popular opinion. Caliban, in the *Tempest*, would have shocked the mind as an improbability, if we had not been made acquainted with his origin, and seen his character displayed in a series of consistent behaviour. But when we are told that he sprung from a witch and a demon, a connection not contrary to the laws of nature, as they were understood in Shakespeare's time, and find his manners conformable to his descent, we are easily reconciled to the fiction. In the same sense, the Lilliputians of Swift may pass for probable beings; not so much because we know that a belief in pigmies was once current in the world (for the true ancient pigmy was at least thrice as tall as those whom Gulliver visited), but because we find that every circumstance relating to them accords with itself, and with their supposed character. It is not the size of the people only that is diminutive; their country, seas, ships, and towns, are all in exact proportion; their theological and political principles, their passions, manners, customs, and all the parts of their conduct, betray a levity and littleness perfectly suitable; and so simple is the whole narration, and apparently so artless and sincere, that we should not much wonder if it had imposed (as we have been told it has) upon some persons of no contemptible understanding. The same degree of credit may perhaps for the same reasons be due to his giants. But when he grounds his narrative upon a contradiction to nature; when he presents us with rational brutes, and irrational men; when he tells us of horses building houses for habitation, milking cows for food, riding in carriages, and holding conversations on the laws and politics of Europe; not all his genius (and he there exerts it to the utmost) is able to reconcile us to so monstrous a fiction: we may smile at some of his absurd exaggerations; we may be pleased with the energy of style, and accuracy of description, in particular places; and a malevolent heart may triumph in the satire; but we can never relish it as a fable, because it is at once unnatural and self-contradictory. Swift's judgment seems to have forsaken him on this occasion: he wallows in nastiness and brutality: and the general run of his satire is downright defamation. Lucian's *True History* is a heap of extravagancies put together without order or unity, or any other apparent design than to ridicule the language and manner of grave authors. His ravings, which have no better right to the name of *fable*, than a hill of rubbish has to that of palace, are destitute of every colour of plausibility. Animal trees, ships sailing in the sky, armies of monstrous things travelling between the sun and moon on a pavement of cobwebs, rival nations of men inhabiting woods and mountains in a whale's belly,—are liker the dreams of a bedlamite than the inventions of a rational being.

If we were to prosecute this subject any farther, it would be proper to remark, that in some kinds of poe-

tical invention a stricter probability is required than in others:—that, for instance, Comedy, whether dramatic or narrative (B), must seldom deviate from the ordinary course of human affairs, because it exhibits the manners of real and even of familiar life:—that the tragic poet, because he imitates characters more exalted, and generally refers to events little known, or long since past, may be allowed a wider range; but must never attempt the marvellous fictions of the epic muse, because he addresses his work, not only to the passions and imagination of mankind, but also to their eyes and ears, which are not easily imposed on, and refuse to be gratified with any representation that does not come very near the truth:—that the epic poem may claim still ampler privileges, because its fictions are not subject to the scrutiny of any outward sense, and because it conveys information in regard both to the highest human characters, and the most important and wonderful events, and also to the affairs of unseen worlds and superior beings. Nor would it be improper to observe, that the several species of comic, of tragic, of epic composition, are not confined to the same degree of probability: for that farce may be allowed to be less probable than the regular comedy; the masque than the regular tragedy; and the mixed epic, such as the *Fairy Queen*, and *Orlando Furioso*, than the pure epopee of Homer, Virgil, and Milton. But this part of the subject seems not to require further illustration. Enough has been said to show, that nothing unnatural can please; and that therefore poetry, whose end is to please, must be according to nature.

And if so, it must be either according to real nature, or according to nature somewhat different from the reality.

SECT. III. Of the System of Nature exhibited by Poetry.

To exhibit *real nature* is the business of the historian; who, if he were strictly to confine himself to his own sphere, would never record even the minutest circumstance of any speech, event, or description, which was not warranted by sufficient authority. It has been the language of critics in every age, that the historian ought to relate nothing as true which is false or dubious, and to conceal nothing material which he knows to be true. But it is to be doubted whether any writer of profane history has ever been so scrupulous. Thucydides himself, who began his history when that war began which he records, and who set down every event soon after it happened, according to the most authentic information, seems, however, to have indulged his fancy not a little in his harangues and descriptions, particularly that of the plague of Athens: and the same thing has been practised, with greater latitude, by Livy and Tacitus, and more or less by all the best historians both ancient and modern. Nor are they to be blamed for it. By these improved or invented speeches, and by the heightenings thus given to their descriptions, their work becomes more interesting, and more useful; nobody is de-

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(B) Fielding's *Tom Jones*, *Amelia*, and *Joseph Andrews*, are examples of what may be called the *Epic* or *Narrative Comedy*, or more properly perhaps the *Comic Epopee*.

Of
Nature in
Poetry.

ceived, and historical truth is not materially affected. A medium is, however, to be observed in this, as in other things. When the historian lengthens a description into a detail of fictitious events, as Voltaire has done in his account of the battle of Fontenoy, he loses his credit with us, by raising a suspicion that he is more intent upon a pretty story than upon the truth. And we are disgusted with his insincerity, when, in defiance even of verisimilitude, he puts long elaborate orations in the mouth of those, of whom we know, either from the circumstances that they could not, or from more authentic records that they did not, make any such orations; as Dionysius of Halicarnassus has done in the case of Volumnia haranguing her son Coriolanus, and Flavius Josephus in that of Judah addressing his brother as viceroy of Egypt. From what these historians relate, one would conjecture that the Roman matron had studied at Athens under some long-winded rhetorician, and that the Jewish patriarch must have been one of the most flowery orators of antiquity. But the fictitious part of history, or of story-telling, ought never to take up much room; and must be highly blameable when it leads into any mistake either of facts or of characters.

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Now, why do historians take the liberty to embellish their works in this manner? One reason, no doubt, is, that they may display their talents in oratory and narration: but the chief reason, as hinted already, is, to render their composition more agreeable. It would seem, then, that something more pleasing than real nature, or something which shall add to the pleasing qualities of real nature, may be devised by human fancy. And this may certainly be done. And this it is the poet's business to do. And when this is in any degree done by the historian, his narrative becomes in that degree poetical.

Beattie's
Essays,
chap. ii.

The possibility of thus improving upon nature must be obvious to every one. When we look at a landscape, we can fancy a thousand additional embellishments. Mountains loftier and more picturesque; rivers more copious, more limpid, and more beautifully winding; smoother and wider lawns; valleys more richly diversified; caverns and rocks more gloomy and more stupendous; ruins more majestic; buildings more magnificent; oceans more varied with islands, more splendid with shipping, or more agitated by storm, than any we have ever seen—it is easy for human imagination to conceive. Many things in art and nature exceed expectation; but nothing sensible transcends or equals the capacity of thought:—a striking evidence of the dignity of the human soul! The finest woman in the world appears to every eye susceptible of improvement, except perhaps to that of her lover. No wonder, then, if in poetry events can be exhibited more compact, and of more pleasing variety, than those delineated by the historian, and scenes of inanimate nature more dreadful or more lovely, and human characters more sublime and more exquisite, both in good and evil. Yet still let nature supply the ground-work and materials, as well as the standard, of poetical fiction. The most expert painters use a layman, or other visible figure, to direct their hand and regulate their fancy. Homer himself founds his two poems on authentic tradition; and tragedy as well as epic poets have followed the example. The writers of romance, too, are ambitious to interweave true adventures with their fables; and when it can be conve-

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niently done, to take the outlines of their plan from real life. Thus the tale of Robinson Crusoe is founded on an incident that actually befel one Alexander Selkirk, a sea-faring man, who lived several years alone in the island of Juan Fernandes: Smollet is thought to have given us several of his own adventures in the history of Roderic Random: and the chief characters in Tom Jones, Joseph Andrews, and Pamela, are said to have been copied from real originals. Dramatic comedy, indeed, is for the most part purely fictitious: for if it were to exhibit real events as well as present manners, it would become too personal to be endured by a well-bred audience, and degenerate into downright abuse; which appears to have been the case with the old comedy of the Greeks*. But in general, hints taken from real existence will be found to give no little grace and stability to fiction, even in the most fanciful poems. Those hints, however, may be improved by the poet's imagination, and set off with every probable ornament that can be devised, consistently with the design and genius of the work; or, in other words, with the sympathies that the poet means to awaken in the mind of his reader. For mere poetical ornament, when it fails to interest the affections, is not only useless, but improper; all true poetry being addressed to the heart, and intended to give pleasure by raising or soothing the passions;—the only effectual way of pleasing a rational and moral creature. And therefore we would take Horace's maxim to be universal in poetry: "*Non satis est, pulchra esse poemata; dulcia suntu*." "It is not enough that poems be beautiful; let them also be affecting."—For that this is the meaning of the word *dulcia* in this place, is admitted by the best interpreters, and is indeed evident from the context†.

† Hor. A.
Poet. ver.
95—100.
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That the sentiments and feelings of percipient beings, when expressed in poetry, should call forth our affections, is natural enough; but can descriptions of inanimate things also be made affecting? certainly they can: and the more they affect, the more they please us, and the more poetical we allow them to be. Virgil's Georgic is a noble specimen (and indeed the noblest in the world) of this sort of poetry. His admiration of eternal nature gains upon a reader of taste, till it rise to perfect enthusiasm. The following observations will perhaps explain this matter.

Every thing in nature is complex in itself, and bears innumerable relations to other things; and may therefore be viewed in an endless variety of lights, and consequently described in an endless variety of ways. Some descriptions are good, and others bad. An historical description, that enumerates all the qualities of any object, is certainly good, because it is true; but may be as uninteresting as a logical definition. In poetry, no uninteresting description is good, however conformable to truth: for here we expect not a complete enumeration of qualities (the chief end of the art being to please), but only such an enumeration as may give a lively and interesting idea. It is not memory, or the knowledge of rules, that can qualify a poet for this sort of description; but a peculiar liveliness of fancy and sensibility of heart, the nature whereof we may explain by its effects, but we cannot lay down rules for the attainment of it.

When our mind is occupied by any emotion, we naturally use words and meditate on things that are suitable

Of
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able to it and tend to encourage it. If a man were to write a letter when he is very angry, there would probably be something of vehemence or bitterness in the style, even though the person to whom he wrote were not the object of his anger. The same thing holds true of every other strong passion or emotion:—while it predominates in the mind, it gives a peculiarity to our thoughts, as well as to our voice, gesture, and countenance: And hence we expect, that every personage introduced in poetry should see things through the medium of his ruling passion, and that his thoughts and language should be tinged accordingly. A melancholy man walking in a grove, attends to those things that suit and encourage his melancholy; the sighing of the wind in the trees, the murmuring of waters, the darkness and solitude of the shades: A cheerful man in the same place, finds many subjects of cheerful meditation, in the singing of birds, the brisk motions of the babbling stream, and the liveliness and variety of the verdure. Persons of different characters, contemplating the same thing, a Roman triumph, for instance, feel different emotions, and turn their view to different objects. One is filled with wonder at such a display of wealth and power; another exults in the idea of conquest, and pants for military renown; a third, stunned with clamour, and harassed with confusion, wishes for silence, security, and solitude; one melts with pity to the vanquished, and makes many a sad reflection upon the insignificance of worldly grandeur, and the uncertainty of human things; while the buffoon, and perhaps the philosopher, considers the whole as a vain piece of pageantry, which, by its solemn procedure, and by the admiration of so many people, is only rendered the more ridiculous:—and each of these persons would describe it in a way suitable to his own feelings, and tending to raise the same in others. We see in Milton's *Allegro* and *Penso*, how a different cast of mind produces a variety in the manner of conceiving and contemplating the same rural scenery. In the former of these excellent poems, the author personates a cheerful man, and takes notice of those things in external nature that are suitable to cheerful thoughts, and tend to encourage them: in the latter, every object described is serious and solemn, and productive of calm reflection and tender melancholy: and we should not be easily persuaded, that Milton wrote the first under the influence of sorrow, or the second under that of gladness. We often see an author's character in his works; and if every author were in earnest when he writes, we should oftener see it. Thomson was a man of piety and benevolence, and a warm admirer of the beauties of nature; and every description in his delightful poem on the *Seasons* tends to raise the same laudable affections in his reader. The parts of nature that attract his notice are those which an impious or hard-hearted man would neither attend to, nor be affected with, at least in the same manner. In Swift we see a turn of mind very different from that of the amiable Thomson; little relish for the sublime or beautiful, and a perpetual succession of violent emotions. All his pic-

VOL. XV. Part I.

tures of human life seem to show, that deformity and meanness were the favourite objects of his attention, and that his soul was a constant prey to indignation (c), disgust, and other gloomy passions, arising from such a view of things. And it is the tendency of almost all his writings (though it was not always the author's design), to communicate the same passions to his reader: inasmuch, that notwithstanding his erudition and knowledge of the world, his abilities as a popular orator and man of business, the energy of his style, the elegance of some of his verses, and his extraordinary talents in wit and humour, there is reason to doubt, whether by studying his works any person was ever much improved in piety or benevolence.

And thus we see, how the compositions of an ingenious author may operate upon the heart, whatever be the subject. The affections that prevail in the author himself, direct his attention to objects congenial, and give a peculiar bias to his inventive powers, and a peculiar colour to his language. Hence his work, as well as face, if nature is permitted to exert herself freely in it, will exhibit a picture of his mind, and awaken correspondent sympathies in the reader. When these are favourable to virtue, which they always ought to be, the work will have that sweet pathos to which Horace alludes in the passage above mentioned; and which we so highly admire, and so warmly approve, even in those parts of the *Georgic* that describe inanimate nature.

Horace's account of the matter in question differs not from what is here given. "It is not enough (says he*) that poems be beautiful; let them be affecting, and agitate the mind with whatever passions the poet wishes to impart. The human countenance, as it smiles on those who smile, accompanies also with sympathetic tears those who mourn. If you would have me weep, you must first weep yourself; then, and not before, shall I be touched with your misfortunes.—For nature first makes the emotions of our mind correspond with our circumstances, infusing real joy, sorrow, or resentment, according to the occasion; and afterwards gives the true pathetic utterance to the voice and language." This doctrine, which concerns the orator and the player no less than the poet, is strictly philosophical, and equally applicable to dramatic, to descriptive, and indeed to every species of interesting poetry. The poet's sensibility must first of all engage him warmly in his subject, and in every part of it; otherwise he will labour in vain to interest the reader. If he would paint external nature, as Virgil and Thomson have done, so as to make her amiable to others, he must first be enamoured of her himself; if he would have his heroes and heroines speak the language of love or sorrow, devotion or courage, ambition or anger, benevolence or pity, his heart must be susceptible of those emotions, and in some degree feel them, as long at least as he employs himself in framing words for them; being assured, that

He best shall paint them who can feel them most.

Pope's *Eloisa*, v. 366.

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It is thus
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* *Ar. Poet.*
v 99--111.

(c) For part of this remark we have his own authority, often in his letters, and very explicitly in the Latin epitaph which he composed for himself:—"ubi sæva indignatio ulterius cor lacerare nequit." See his *last will and testament*.

Of
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* Poetic.
sect. 9.

The true poet, therefore, must not only study nature, and know the reality of things, but must also possess fancy, to invent additional decorations; judgment, to direct him in the choice of such as accord with verisimilitude; and sensibility, to enter with ardent emotions into every part of his subject, so as to transfuse into every part of his work a pathos and energy sufficient to raise corresponding emotions in the reader.

"The historian and the poet (says Aristotle *) differ in this, that the former exhibits things as they are, the latter as they might be;"—i. e. in that state of perfection which is consistent with probability, and in which, for the sake of our own gratification, we wish to find them. If the poet, after all the liberties he is allowed to take with the truth, can produce nothing more exquisite than is commonly to be met with in history, his reader will be disappointed and dissatisfied. Poetical representations must therefore be framed after a pattern of the highest probable perfection that the genius of the work will admit:—external nature must in them be more picturesque than in reality; action more animated; sentiments more expressive of the feelings and character, and more suitable to the circumstances of the speaker; personages better accomplished in those qualities that raise admiration, pity, terror, and other ardent emotions; and events more compact, more clearly connected with causes and consequences, and unfolded in an order more flattering to the fancy, and more interesting to the passions. But where, it may be said, is this pattern of perfection to be found? Not in real nature; otherwise history, which delineates real nature, would also delineate this pattern of perfection. It is to be found only in the mind of the poet; and it is imagination, regulated by knowledge, that enables him to form it.

In the beginning of life, and while experience is confined to a small circle, we admire every thing, and are pleased with very moderate excellence. A peasant thinks the hall of his landlord the finest apartment in the universe, listens with rapture to the strolling ballad-singer, and wonders at the rude wooden cuts that adorn his ruder compositions. A child looks upon his native village as a town; upon the brook that runs by as a river; and upon the meadows and hills in the neighbourhood as the most spacious and beautiful that can be. But when, after long absence, he returns in his declining years, to visit, once before he die, the dear spot that gave him birth, and those scenes whereof he remembers rather the original charms than the exact proportions; how is he disappointed to find every thing so debased and so diminished! The hills seem to have sunk into the ground, the brook to be dried up, and the village to be forsaken of its people; the parish-church, stripped of all its fancied magnificence, is become low, gloomy, and narrow; and the fields are now only the miniature of what they were. Had he never left this spot, his notions might have remained the same as at first; and had he travelled but a little way from it, they would not perhaps have received any material enlargement. It seems then to be from observation of many things of the same or similar kinds, that we acquire the talent of forming ideas more perfect than the real objects that lie immediately around us: and these ideas we may improve gradually more and more, according to the vivacity of our mind, and extent of our experience, till at

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last we come to raise them to a degree of perfection superior to any thing to be found in real life. There cannot surely be any mystery in this doctrine; for we think and speak to the same purpose every day. Thus nothing is more common than to say, that such an artist excels all we have ever known in his profession, and yet that we can still conceive a superior performance. A moralist, by bringing together into one view the separate virtues of many persons, is enabled to lay down a system of duty more perfect than any he has ever seen exemplified in human conduct. Whatever be the emotion the poet intends to raise in his reader, whether admiration or terror, joy or sorrow; and whatever be the object he would exhibit, whether Venus or Tisiphone, Achilles or Therfites, a palace or a pile of ruins, a dance or a battle; he generally copies an idea of his own imagination; considering each quality as it is found to exist in several individuals of a species, and thence forming an assemblage more or less perfect in its kind, according to the purpose to which he means to apply it.

Hence it would appear, that the ideas of poetry are rather general than singular; rather collected from the examination of a species or class of things, than copied from an individual. And this, according to Aristotle, is in fact the case, at least for the most part; whence that critic determines, that poetry is something more exquisite and more philosophical than history*. The historian may describe Bucephalus, but the poet delineates a war-horse; the former must have seen the animal he speaks of, or received authentic information concerning it, if he mean to describe it historically; for the latter, it is enough that he has seen several animals of that sort. The former tells us, what Achilles actually did and said; the latter, what such a species of human character as that which bears the name of Achilles would probably do or say in certain given circumstances.

It is indeed true, that the poet may, and often does, copy after individual objects. Homer, no doubt, took his characters from the life; or at least, in forming them, was careful to follow tradition as far as the nature of his plan would allow. But he probably took the freedom to add or heighten some qualities, and take away others; to make Achilles, for example, stronger, perhaps, and more impetuous, and more eminent for filial affection, and Hector more patriotic and more amiable than he really was. If he had not done this, or something like it, his work would have been rather a history than a poem; would have exhibited men and things as they were, and not as they might have been; and Achilles and Hector would have been the names of individual and real heroes; whereas, according to Aristotle, they are rather to be considered as two distinct modifications or species of the heroic character. Shakespeare's account of the cliffs of Dover comes so near the truth, that we cannot doubt of its having been written by one who had seen them: but he who takes it for an exact historical description, will be surprised when he comes to the place, and finds those cliffs not half so lofty as the poet had made him believe. An historian would be to blame for such amplification; because, being to describe an individual precipice, he ought to tell us just what it is; which if he did, the description would suit that place, and perhaps no other in

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in the whole world. But the poet means only to give an idea of what such a precipice may be; and therefore his description may perhaps be equally applicable to many such chalky precipices on the sea-shore.

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This method of copying after general ideas formed by the artist from observation of many individuals, distinguishes the Italian and all the sublime painters, from the Dutch and their imitators. These give us bare nature, with the imperfections and peculiarities of individual things or persons; but those give nature improved as far as probability and the design of the piece will admit. Teniers and Hogarth draw faces, and figures, and dresses, from real life, and present manners; and therefore their pieces must in some degree lose the effect, and become awkward, when the present fashions become obsolete. — Raphael and Reynolds take their models from general nature; avoiding, as far as possible, (at least in all their great performances), those peculiarities that derive their beauty from mere fashion; and therefore their works must give pleasure, and appear elegant, as long as men are capable of forming general ideas, and of judging from them. The last-mentioned incomparable artist is particularly observant of children, whose looks and attitudes, being less under the controul of art and local manners, are more characteristical of the species than those of men and women. This field of observation has supplied him with many fine figures, particularly that most exquisite one of Comedy, struggling for and winning (for who could resist her!) the affections of Garrick: — a figure which could never have occurred to the imagination of a painter who had confined his views to grown persons looking and moving in all the formality of polite life; — a figure which in all ages and countries would be pronounced natural and engaging; — whereas those human forms that we see every day bowing and courtesying, and strutting, and turning out their toes *secundum artem*, and dressed in ruffles, and wigs, and flounces, and hoop-petticoats, and full-trimmed suits, would appear elegant no further than the present fashions are propagated, and no longer than they remain unaltered.

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There is, in the progress of human society, as well as of human life, a period to which it is of great importance for the higher order of poets to attend, and from which they will do well to take their characters, and manners, and the era of their events; namely, that wherein men are raised above savage life, and considerably improved by arts, government, and conversation; but not advanced so high in the ascent towards politeness, as to have acquired a habit of disguising their thoughts and passions, and of reducing their behaviour to the uniformity of the mode. Such was the period which Homer had the good fortune (as a poet) to live in, and to celebrate. This is the period at which the manners of men are most picturesque, and their adventures most romantic. This is the period when the appetites unperverted by luxury, the powers unenervated by effeminacy, and the thoughts disengaged from artificial restraint, will, in persons of similar dispositions and circumstances, operate in nearly the same way; and when, consequently, the characters of particular men will approach to the nature of poetical or general ideas, and, if well imitated, give pleasure to the whole, or at least to a great majority of mankind.

But a character tinged with the fashions of polite life would not be so generally interesting. Like a human figure adjusted by a modern dancing-master, and dressed by a modern tailor, it may have a good effect in satire, comedy, or farce: but if introduced into the higher poetry, it would be admired by those only who had learned to admire nothing but present fashions, and by them no longer than the present fashions lasted; and to all the rest of the world would appear awkward, unaffecting, and perhaps ridiculous. But Achilles and Sarpedon, Diomedes and Hector, Nestor and Ulysses, as drawn by Homer, must in all ages, independently on fashion, command the attention and admiration of mankind. These have the qualities that are universally known to belong to human nature; whereas the modern fine gentleman is distinguished by qualities that belong only to a particular age, society, and corner of the world. We speak not of moral or intellectual virtues, which are objects of admiration to every age; but of those outward accomplishments, and that particular temperature of the passions, which form the most perceptible part of a human character. — As, therefore, the politician, in discussing the rights of mankind, must often allude to an imaginary state of nature; so the poet who intends to raise admiration, pity, terror, and other important emotions, in the generalty of mankind, especially in those readers whose minds are most improved, must take his pictures of life and manners, rather from the heroic period we now speak of, than from the ages of refinement; and must therefore (to repeat the maxim of Aristotle) “exhibit things, not as they are, but as they might be.”

SECT. IV. Of Poetical Characters.

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HORACE seems to think, that a competent know-
ledge of moral philosophy will fit an author for assign-
ing the suitable qualities and duties to each poetical
personage: (*Art. Poet.* v. 309.—316.) The maxim
may be true, as far as mere morality is the aim of
the poet; but cannot be understood to refer to the de-
lineation of poetical characters in general: for a thorough
acquaintance with all the moral philosophy in the world
would not have enabled Blackmore to paint such a per-
sonage as Homer's Achilles, Shakespeare's Othello, or
the Satan of *Paradise Lost*. To a competency of moral
science, there must be added an extensive knowledge
of mankind, a warm and elevated imagination, and the
greatest sensibility of heart, before a genius can be
formed equal to so difficult a task. Horace is in-
deed so sensible of the danger of introducing a new
character in poetry, that he even discourages the at-
tempt, and advises the poet rather to take his persons
from the ancient authors, or from tradition: *Ibid.* v.
119.—130.

To conceive the idea of a good man, and to invent
and support a great poetical character, are two very
different things, however they may seem to have been
confounded by some late critics. The first is easy to
any person sufficiently instructed in the duties of life:
the last is perhaps of all the efforts of human genius
the most difficult; so very difficult, that, though at-
tempted by many, Homer, Shakespeare, and Milton,
are almost the only authors who have succeeded in it.
But characters of perfect virtue are not the most pro-

Of Poetical
Characters.

per for poetry. It seems to be agreed, that the Deity should not be introduced in the machinery of a poetical fable. To ascribe to him words and actions of our own invention, seems very unbecoming; nor can a poetical description, that is known to be, and must of necessity be, infinitely inadequate, ever satisfy the human mind. Poetry, according to the best critics, is an imitation of human action; and therefore poetical characters, though elevated, should still partake of the passions and frailties of humanity. If it were not for the vices of some principal personages, the *Iliad* would not be either so interesting or so moral: the most moving and most eventful parts of the *Æneid* are those that describe the effects of unlawful passion:—the most instructive tragedy in the world, we mean *Macbeth*, is founded in crimes of dreadful enormity:—and if Milton had not taken into his plan the fall of our first parents, as well as their state of innocence, his divine poem must have wanted much of its pathos, and could not have been (what it now is) such a treasure of important knowledge, as no other uninspired writer ever comprehended in so small a compass. — Virtue, like truth, is uniform and unchangeable. We may anticipate the part a good man will act in any given circumstances: and therefore the events that depend on such a man must be less surprising than those which proceed from passion; the vicissitudes whereof it is frequently impossible to foresee. From the violent temper of Achilles, in the *Iliad*, spring many great incidents; which could not have taken place, if he had been calm and prudent like Ulysses, or pious and patriotic like Eneas:—his rejection of Agamemnon's offers, in the ninth book, arises from the violence of his resentment;—his yielding to the request of Patroclus, in the 16th, from the violence of his friendship (if we may so speak) counteracting his resentment; and his restoring to Priam the dead body of Hector, in the 24th, from the violence of his affection to his own aged father, and his regard to the command of Jupiter, counteracting, in some measure, both his sorrow for his friend, and his thirst for vengeance. — Besides, except where there is some degree of vice, it pains us too exquisitely to see misfortune; and therefore poetry would cease to have a pleasurable influence over our tender passions, if it were to exhibit virtuous characters only. And as in life, evil is necessary to our moral probation, and the possibility of error to our intellectual improvement; so bad or mixed characters are useful in poetry, to give to the good such opposition, as puts them upon displaying and exercising their virtue.

26
Whilst the
personages
in whose
fate the
poet means
that we
should be
interested
ought to
have good
and great
qualities.

All those personages, however, in whose fortune the poet means that we should be interested, must have agreeable and admirable qualities to recommend them to our regard. And perhaps the greatest difficulty in the art lies in suitably blending those faults which the

poet finds it expedient to give to any particular hero, with such moral, intellectual, or corporeal accomplishments, as may engage our esteem, pity, or admiration, without weakening our hatred of vice, or love of virtue. In most of our novels, and in many of our plays, it happens unluckily, that the hero of the piece is so captivating, as to incline us to be indulgent to every part of his character, the bad as well as the good. But a great master knows how to give the proper direction to human sensibility; and, without any perversion of our faculties, or any confusion of right and wrong, to make the same person the object of very different emotions, of pity and hatred, of admiration and horror. Who does not esteem and admire *Macbeth* for his courage and generosity? who does not pity him when beset with all the terrors of a pregnant imagination, superstitious temper, and awakened conscience? who does not abhor him as a monster of cruelty, treachery, and ingratitude? His good qualities, by drawing us near to him, make us, as it were, eye-witnesses of his crime, and give us a fellow-feeling of his remorse; and therefore, his example cannot fail to have a powerful effect in cherishing our love of virtue, and fortifying our minds against criminal impressions: whereas, had he wanted those good qualities, we should have kept aloof from his concerns, or viewed them with a superficial attention; in which case his example would have had little more weight than that of the robber, of whom we know nothing, but that he was tried, condemned, and executed. — Satan, in *Paradise Lost*, is a character drawn and supported with the most consummate judgment. The old furies and demons, Hecate, Tisiphone, Alecto, Megara, are objects of unmixed and unmitigated abhorrence; Tityus, Encecladus, and their brethren, are remarkable for nothing but impiety, deformity, and vastness of size; Pluto is, at best, an insipid personage; Mars, a hair-brained ruffian; Tasso's infernal tyrant, an ugly and overgrown monster:—but in the Miltonic Satan, we are forced to admire the majesty of the ruined archangel, at the same time that we detest the unconquerable depravity of the fiend. “But, of all poetical characters, (says the elegant critic from whom we are extracting), the Achilles of Homer (D) seems to me the most exquisite of invention, and the most highly finished. The utility of this character in a moral view is obvious; for it may be considered as the source of all the morality of the *Iliad*. Had not the generous and violent temper of Achilles determined him to patronise the augur Calchas in defiance of Agamemnon, and afterwards, on being affronted by that vindictive commander, to abandon for a time the common cause of Greece;—the fatal effects of dissension among confederates, and of capricious and tyrannical behaviour in a sovereign, would not have been the leading moral of Homer's

Beattie's
Essays.

(D) “I say the *Achilles* of HOMER. Latter authors have degraded the character of this hero, by supposing every part of his body invulnerable except the heel. I know not how often I have heard this urged as one of Homer's absurdities; and indeed the whole *Iliad* is one continued absurdity, on this supposition. But Homer all along makes his hero equally liable to wounds and death with other men. Nay, to prevent all mistakes in regard to this matter, (if those who cavil at the poet would but read his work), he actually wounds him in the right arm by the lance of Asteropæus, in the battle near the river Scamander.” See *Iliad*, xxi. ver. 161.—168.

Of poetical Characters. — Homer's poetry; nor could Hector, Sarpedon, Eneas, Ulysses, and the other amiable heroes, have been brought forward to signalize their virtues, and to recommend themselves to the esteem and imitation of mankind.

The excellency of the poetical character of Achilles. — "They who form their judgment of Achilles from the imperfect sketch given of him by Horace in the *Art of Poetry*, (v. 121, 122.); and consider him only as a hateful composition of anger, revenge, fierceness, obduracy, and pride, can never enter into the views of Homer, nor be suitably affected with his narration. All these vices are no doubt, in some degree, combined in Achilles; but they are tempered with qualities of a different sort, which render him a most interesting character, and of course make the *Iliad* a most interesting poem. Every reader abhors the faults of this hero: and yet, to an attentive reader of Homer, this hero must be the object of esteem, admiration, and pity; for he has many good as well as bad affections, and is equally violent in all:—Nor is he possessed of a single vice or virtue, which the wonderful art of the poet has not made subservient to the design of the poem, and to the progress and catastrophe of the action; so that the hero of the *Iliad*, considered as a poetical personage, is just what he should be, neither greater nor less, neither worse nor better.—He is everywhere distinguished by an abhorrence of oppression, by a liberal and elevated mind, by a passion for glory, and by a love of truth, freedom, and sincerity. He is for the most part attentive to the duties of religion; and, except to those who have injured him, courteous and kind: he is affectionate to his tutor Phoenix; and not only pities the misfortunes of his enemy Priam, but in the most soothing manner administers to him the best consolation that Homer's poor theology could furnish. Though no admirer of the cause in which his evil destiny compels him to engage, he is warmly attached to his native land; and, ardent as he is in vengeance, he is equally so in love to his aged father Peleus, and to his friend Patroclus. He is not luxurious like Paris, nor clownish like Ajax; his accomplishments are princely, and his amusements worthy of a hero. Add to this, as an apology for the vehemence of his anger, that the affront he had received was (according to the manners of that age) of the most atrocious nature; and not only unprovoked, but such as, on the part of Agamemnon, betrayed a brutal insensibility to merit, as well as a proud, selfish, ungrateful, and tyrannical disposition. And though he is often inexcusably furious; yet it is but justice to remark, that he was not naturally cruel (E); and that his wildest outrages were such as in those rude times might be expected from a violent man of invincible strength and valour, when exasperated by injury, and frantic with sorrow.—Our hero's claim to the admiration of mankind is indisputable. Every part of his character is sublime and astonishing. In his person, he is the strongest, the swiftest, the most beautiful of men:—this last circumstance, however, occurs not to his own observation, being too trivial to attract

the notice of so great a mind. The Fates had put it in his power, either to return home before the end of the war, or to remain at Troy:—if he chose the former, he would enjoy tranquillity and happiness in his own country to a good old age; if the latter, he must perish in the bloom of his youth:—his affection to his father and native country, and his hatred to Agamemnon, strongly urged him to the first; but a desire to avenge the death of his friend determines him to accept the last, with all its consequences. This at once displays the greatness of his fortitude, the warmth of his friendship, and the violence of his sanguinary passions: and it is this that so often and so powerfully recommends him to the pity, as well as admiration, of the attentive reader."

It is equally a proof of rich invention and exact judgment in Homer, that he mixes some good qualities in all his bad characters, and some degree of imperfection in almost all his good ones.—Agamemnon, notwithstanding his pride, is an able general, and a valiant man, and highly esteemed as such by the greater part of the army.—Paris, though effeminate, and vain of his dress and person, is, however, good-natured, patient of reproof, not destitute of courage, and eminently skilled in music and other fine arts.—Ajax is a huge giant; fearless rather from insensibility to danger, and confidence in his massy arms, than from any nobler principle; boastful and rough; regardless of the gods, though not downright impious: yet there is in his manner something of frankness and blunt sincerity, which entitle him to a share in our esteem; and he is ever ready to assist his countrymen, to whom he renders good service on many a perilous emergency.—The character of Helen, in spite of her faults, and of the many calamities whereof she is the guilty cause, Homer has found means to recommend to our pity, and almost to our love; and this he does, without seeking to extenuate the crime of Paris, of which the most respectable personages in the poem are made to speak with becoming abhorrence. She is so full of remorse, so ready on every occasion to condemn her past conduct, so affectionate to her friends, so willing to do justice to every body's merit, and withal so finely accomplished, that she extorts our admiration, as well as that of the Trojan senators.—Menelaus, though sufficiently sensible of the injury he had received, is yet a man of moderation, clemency, and good-nature, a valiant soldier, and a most affectionate brother: but there is a dash of vanity in his composition, and he entertains rather too high an opinion of his own abilities, yet never overlooks nor undervalues the merit of others.—Priam would claim unreserved esteem, as well as pity, if it were not for his inexcusable weakness, in gratifying the humour, and by indulgence abetting the crimes, of the most worthless of all his children, to the utter ruin of his people, family, and kingdom. Madame Dacier supposes, that he had lost his authority, and was obliged to fall in with the politics of the times: but of this there appears no evidence;

(E) See *Iliad* xxi. 100. and xxiv. 485.—673.—In the first of these passages, Achilles himself declares, that before Patroclus was slain, he often spared the lives of his enemies, and took pleasure in doing it. It is strange, as Dr Beattie observes, that this should be left out in Pope's Translation.

Of Poetical
Characters.

evidence; on the contrary, he and his unworthy favourite Paris seem to have been the only persons of distinction in Troy who were averse to the restoring of Helen. Priam's foible (if it can be called by so soft a name), however faulty, is not uncommon, and has often produced calamity both in private and public life. The Scripture gives a memorable instance in the history of the good old Eli.—Sarpedon comes nearer a perfect character than any other of Homer's heroes; but the part he has to act is short. It is a character which one could hardly have expected in those rude times: a sovereign prince, who considers himself as a magistrate set up by the people for the public good, and therefore bound in honour and gratitude to be himself their example, and study to excel as much in virtue as in rank and authority.—Hector is the favourite of every reader, and with good reason. To the truest valour he joins the most generous patriotism. He abominates the crime of Paris: but not being able to prevent the war, he thinks it his duty to defend his country, and his father and sovereign, to the last. He too, as well as Achilles, foresees his own death; which heightens our compassion, and raises our idea of his magnanimity. In all the relations of private life, as a son, a father, a husband, a brother, he is amiable in the highest degree; and he is distinguished among all the heroes for tenderness of affection, gentleness of manners, and a pious regard to the duties of religion. One circumstance of his character, strongly expressive of a great and delicate mind, we learn from Helen's lamentation over his dead body, that he was almost the only person in Troy who had always treated her with kindness, and never uttered one reproachful word to give her pain, nor heard others reproach her without blaming them for it. Some tendency to ostentation (which, however, may be pardonable in a commander in chief), and temporary fits of timidity, are the only blemishes discoverable in this hero; whose portrait Homer appears to have drawn with an affectionate and peculiar attention.

By ascribing so many amiable qualities to Hector and some others of the Trojans, the poet interests us in the fate of that people, notwithstanding our being continually kept in mind that they are the injurious party. And by thus blending good and evil, virtue and frailty, in the composition of his characters, he makes them the more conformable to the real appearances of human nature, and more useful as examples for our improvement; and at the same time, without hurting verisimilitude, gives every necessary embellishment to particular parts of his poem, and variety, coherence, and animation, to the whole fable. And it may also be observed, that though several of his characters are complex, not one of them is made up of incompatible parts: all are natural and probable, and such as we think we have met with, or might have met with, in our intercourse with mankind.

From the same extensive views of good and evil, in all their forms and combinations, Homer has been enabled to make each of his characters perfectly distinct in itself, and different from all the rest; inasmuch, that before we come to the end of the Iliad, we are as well acquainted with his heroes, as with the faces and tempers of our most familiar friends. Virgil, by confining himself to a few general ideas of fidelity and fortitude, has made his subordinate heroes a very good sort of people;

but they are all the same, and we have no clear knowledge of any one of them. Achates is faithful, and Gyas is brave, and Cloanthus is brave; and this is all we can say of the matter. We see these heroes at a distance, and have some notion of their shape and size; but are not near enough to distinguish their features; and every face seems to exhibit the same faint and ambiguous appearance. But of Homer's heroes we know every particular that can be known. We eat, and drink, and talk, and fight, with them: we see them in action and out of it; in the field and in their tents and houses: the very face of the country about Troy we seem to be as well acquainted with as if we had been there. Similar characters there are among these heroes, as there are similar faces in every society; but we never mistake one for another. Nestor and Ulysses are both wise and both eloquent: but the wisdom of the former seems to be the effect of experience; that of the latter of genius: the eloquence of the one is sweet and copious, but not always to the purpose, and apt to degenerate into story-telling; that of the other is close, emphatical, and persuasive, and accompanied with a peculiar modesty and simplicity of manner. Homer's heroes are all valiant; yet each displays a modification of valour peculiar to himself; one is valiant from principle, another from constitution; one is rash, another cautious; one is impetuous and headstrong, another impetuous, but tractable; one is cruel, another merciful; one is insolent and ostentatious, another gentle and unassuming; one is vain of his person, another of his strength, and a third of his family.—It would be tedious to give a complete enumeration. Almost every species of the heroic character is to be found in Homer.

Of the agents in *Paradise Lost*, it has been observed*, that "the weakest are the highest and noblest of human beings, the original parents of mankind; with whose actions the elements consented; on whose rectitude or deviation of will depended the state of terrestrial nature, and the condition of all the future inhabitants of the globe. Of the other agents in the poem, the chief are such as it is irreverence to name on slight occasions: the rest are lower powers;

—Of which the least could wield
These elements, and arm him with the force
Of all their regions:

Powers, which only the controul of Omnipotence restrains from laying creation waste, and filling the vast expanse of space with ruin and confusion. To display the motives and actions of beings thus superior, so far as human reason can examine, or human imagination represent them, is the task which Milton undertook and performed. The characters in the *Paradise Lost*, which admit of examination, are those of angels and of men: of angels good and evil; of man in his innocent and sinful state.

"Among the angels, the virtue of Raphael is mild and placid, of easy condescension, and free communication: that of Michael is regal and lofty, attentive to the dignity of his own nature. Abdiel and Gabriel appear occasionally, and act as every incident requires: the solitary fidelity of Abdiel is very amiably painted.

"Of the evil angels, the characters are more diversified. To Satan such sentiments are given as suit the most

Of Poetic
Character.

30
The difficulty of drawing and discriminating the characters in *Paradise Lost*.

31
Milton's success in this part of his undertaking.

29
Virgil fails in drawing characters.

most exalted and most depraved being. Milton has been censured for the impiety which sometimes breaks from Satan's mouth; for there are thoughts, it is justly remarked, which no observation of character can justify; because no good man would willingly permit them to pass, however transiently, through his mind. This censure has been shown to be groundless by the great critic from whom we quote. To make Satan speak as a rebel, says he, without any such expressions as might taint the readers' imagination, was indeed one of the great difficulties in Milton's undertaking; and I cannot but think that he has extricated himself with great happiness. There is in Satan's speeches little that can give pain to a pious ear. The language of rebellion cannot be the same with that of obedience: the malignity of Satan foams in haughtiness and obstinacy; but his expressions are commonly general, and no otherwise offensive than as they are wicked.—The other chiefs of the celestial rebellion are very judiciously discriminated; and the ferocious character of Moloch appears, both in the battle and in the council, with exact consistency.

“To Adam and to Eve are given, during their innocence, such sentiments as innocence can generate and utter. Their love is pure benevolence and mutual veneration; their repasts are without luxury, and their diligence without toil. Their addresses to their Maker have little more than the voice of admiration and gratitude: fruition left them nothing to ask, and innocence left them nothing to fear. But with guilt enter distrust and discord, mutual accusation and stubborn self-defence: they regard each other with alienated minds, and dread their Creator as the avenger of their transgression; at last, they seek shelter in his mercy, soften to repentance, and melt in supplication. Both before and after the fall, the different sentiments arising from difference of sex are traced out with inimitable delicacy and philosophical propriety. Adam has always that pre-eminence in dignity, and Eve in loveliness, which we should naturally look for in the father and mother of mankind.”

From what has been said, it seems abundantly evident, —That the end of poetry is to please; and therefore that the most perfect poetry must be the most pleasing; —that what is unnatural cannot give pleasure; and therefore that poetry must be according to nature: —that it must be either according to real nature, or according to nature somewhat different from the reality; —that, if according to real nature, it would give no greater pleasure than history, which is a transcript of real nature; —that greater pleasure is, however, to be expected from it, because we grant it superior indulgence, in regard to fiction, and the choice of words; —and, consequently, that poetry must be, not according to real nature, but according to nature improved to that degree which is consistent with probability and suitable to the poet's purpose. — And hence it is that we call poetry, *An imitation of nature*. —For that which is properly termed *imitation* has always in it something which is not in the original. If the prototype and transcript be exactly alike; if there be nothing in the one which is not in the other; we may call the latter a *representation*, a *copy*, a *draught*, or a *picture*, of the former; but we never call it an *imitation*.

I. The origin of nations, and the beginnings of great events, are little known, and seldom interesting; whence the first part of every history, compared with the sequel, is somewhat dry and tedious. But a poet must, even in the beginning of his work, interest the readers, and raise high expectation; not by any affected pomp of style, far less by ample promises or bold professions; but by setting immediately before them some incident, striking enough to raise curiosity, in regard both to its causes and to its consequences. He must therefore take up his story, not at the beginning, but in the middle; or rather, to prevent the work from being too long, as near the end as possible; and afterwards take some proper opportunity to inform us of the preceding events, in the way of narrative, or by conversation of the persons introduced, or by short and natural digressions.

The action of both the *Iliad* and *Odyssey* begins about six weeks before its conclusion; although the principal events of the war of Troy are to be found in the former; and the adventures of a ten years' voyage, followed by the suppression of a dangerous domestic enemy, in the latter. One of the first things mentioned by Homer in the *Iliad*, is a plague, which Apollo in anger sent into the Grecian army commanded by Agamemnon and now encamped before Troy. Who this Agamemnon was, and who the Grecians were; for what reason they had come hither; how long the siege had lasted; what memorable actions had been already performed; and in what condition both parties now were: — all this, and much more, we soon learn from occasional hints and conversations interspersed through the poem.

In the *Æneid*, which, though it comprehends the transactions of seven years, opens within a few months of the concluding event, we are first presented with a view of the Trojan fleet at sea, and no less a person than Juno interesting herself to raise a storm for their destruction. This excites a curiosity to know something further: who these Trojans were, whence they had come, and whither they were bound; why they had left their own country, and what had befallen them since they left it. On all these points, the poet, without quitting the track of his narrative, soon gives the fullest information: The storm rises; the Trojans are driven to Africa, and hospitably received by the queen of the country; at whose desire their commander relates his adventures.

The action of *Paradise Lost* commences not many days before Adam and Eve are expelled from the garden of Eden, which is the concluding event. This poem, as its plan is incomparably more sublime and more important than that of either the *Iliad* or *Æneid*, opens with a far more interesting scene: a multitude of angels and archangels shut up in a region of torment and darkness, and rolling on a lake of unquenchable fire. Who these angels are, and what brought them into this miserable condition, we naturally wish to know; and the poet in due time informs us; partly from the conversation of the fiends themselves; and more particularly by the mouth of a happy spirit, sent from heaven to caution the father and mother of mankind against temptation, and confirm their good resolutions by unfolding the dreadful effects of impiety and disobedience.

Of Poetical
Arrangement, &c.

Beattie,
ut supra.

34
The advantages of the
poetical arrangement.

This poetical arrangement of events, so different from the historical, has other advantages besides those arising from brevity and compactness of detail: it is obviously more affecting to the fancy, and more alarming to the passions; and, being more suitable to the order and the manner in which the actions of other men strikes our senses, is a more exact imitation of human affairs. I hear a sudden noise in the street, and run to see what is the matter. An insurrection has happened, a great multitude is brought together, and something very important is going forward. The scene before me is the first thing that engages my attention; and is in itself so interesting, that for a moment or two I look at it in silence and wonder. By and by, when I get time for reflection, I begin to inquire into the cause of all this tumult, and what it is the people would be at; and one who is better informed than I, explains the affair from the beginning; or perhaps I make this out for myself, from the words and actions of the persons principally concerned.—This is a sort of picture of poetical arrangement, both in epic and dramatic composition; and this plan has been followed in narrative odes and ballads both ancient and modern.—The historian pursues a different method. He begins perhaps with an account of the manners of a certain age, and of the political constitution of a certain country; then introduces a particular person, gives the story of his birth, connections, private character, pursuits, disappointments, and of the events that promoted his views, and brought him acquainted with other turbulent spirits like himself; and so proceeds, unfolding, according to the order of time, the causes, principles, and progress of the conspiracy, if that be the subject which he undertakes to illustrate. It cannot be denied, that this latter method is more favourable to calm information: but the former, compared with it, will be found to have all the advantages already specified, and to be more effectually productive of that mental pleasure which depends on the passions and imagination.

35
Unity of
design necessary
to the higher
poetry.

II. If a work have no determinate end, it has no meaning; and if it have many ends, it will distract by its multiplicity. Unity of design, therefore, belongs in some measure to all compositions, whether in verse or prose. But to some it is more essential than to others; and to none so much as in the higher poetry. In certain kinds of history, there is unity sufficient if all the events recorded be referred to one person; in others, if to one period of time, or to one people, or even to the inhabitants of one and the same planet. But it is not enough that the subject of a poetical fable be the exploits of one person; for these may be of various and even of opposite sorts and tendencies, and take up longer time than the nature of poetry can admit:—far less can a regular poem comprehend the affairs of one period or of one people:—it must be limited to one great action or event, to the illustration of which all the subordinate events must contribute; and these must be so connected with one another, as well as with the poet's general purpose, that one cannot be changed, transposed, or taken away, without affecting the consistence and stability of the whole*. In itself an incident may be interesting, a character well drawn, a description beautiful; and yet, if it disfigure the general plan, or if it obstruct or incumber the main action, instead of helping it forward, a correct artist would consider it but as a gaudy

* *Arif.*
Poet. § 8.

superfluity or splendid deformity; like a piece of scarlet cloth sewed upon a garment of a different colour†. Not that all the parts of the fable either are, or can be, equally essential. Many descriptions and thoughts, of little consequence to the plan, may be admitted for the sake of variety; and the poet may, as well as the historian and philosopher, drop his subject for a time, in order to take up an affecting or instructive digression.

III. The doctrine of poetical digressions and episodes has been largely treated by the critics. We shall here only remark, that, in estimating their propriety, three things are to be attended to:—their connection with the fable or subject; their own peculiar excellence; and their subserviency to the poet's design.

(1.) Those digressions that both arise from and terminate in the subject, like the episode of the angel Raphael in *Paradise Lost*, and the transition to the death of Cæsar and the civil wars in the first book of the *Georgic*, are the most artful, and if suitably executed claim the highest praise:—those that arise from, but do not terminate in, the subject, are perhaps second in the order of merit; like the story of Dido in the *Æneid*, and the encomium on a country life in the second book of the *Georgic*:—those come next that terminate in, but do not rise from, the fable; of which there are several in the third book of the *Æneid*, and in the *Odyssey*:—and those that neither terminate in the fable nor rise from it are the least artful; and if they be long, cannot escape censure, unless their beauty be very great.

But (2.) we are willing to excuse a beautiful episode at whatever expence to the subject it may be introduced. They who can blame Virgil for obtruding upon them the charming tale of Orpheus and Euridice in the fourth *Georgic*, or Milton for the apostrophe to light in the beginning of his third book, ought to forfeit all title to the perusal of good poetry; for of such divine strains one would rather be the author than of all the books of criticism in the world. Yet still it is better that an episode possess the beauty of connection, together with its own intrinsic elegance, than this without the other.

Moreover, in judging of the propriety of episodes and other similar contrivances, it may be expedient to attend (3.) to the design of the poet, as distinguished from the fable or subject of the poem. The great design, for example, of Virgil, was to interest his countrymen in a poem written with a view to reconcile them to the person and government of Augustus. Whatever, therefore, in the poem tends to promote this design, even though it should in some degree hurt the contexture of the fable, is really a proof of the poet's judgment; and may be not only allowed, but applauded.—The progress of the action of the *Æneid* may seem to be too long obstructed in one place by the story of Dido, which, though it rises from the preceding part of the poem, has no influence upon the sequel; and, in another, by the episode of Cæus, which, without injury to the fable, might have been omitted altogether. Yet these episodes, interesting as they are to us and all mankind because of the transcendent merit of the poetry, must have been still more interesting to the Romans because of their connection with the Roman affairs; for the one accounts poetically for their wars with Carthage; and the other not only explains some of their religious ceremonies, but also gives a most charming rural picture of those hills and valleys in the neighbourhood of the Tiber, on which,

36

The propriety of digressions and episodes depends upon

37

Their connection with the subject of the poem.

38

Their own peculiar excellence, and

39

Their subserviency to the poet's design.

Of Poetical
Arrangement, &c.

And if we consider, that the design of Homer's Iliad was not only to show the fatal effects of dissension among confederates, but also to immortalize his country, and celebrate the most distinguished families in it, we shall be inclined to think more favourably than critics generally do of some of his long speeches and digressions; which, though to us they may seem trivial, must have been very interesting to his countrymen on account of the genealogies and private history recorded in them.—Shakespeare's historical plays, considered as dramatic fables, and tried by the laws of tragedy and comedy, appear very rude compositions; but if we attend to the poet's design (as the elegant critic * has with equal truth and beauty explained it), we shall be forced to admire his judgment in the general conduct of those pieces, as well as unequalled success in the execution of particular parts.

* Says on writings an enius of Shakespeare.

There is yet another point of view in which these digressions may be considered. If they tend to elucidate any important character, or to introduce any interesting event not otherwise within the compass of the poem, or to give an amiable display of any particular virtue, they may be intitled, not to our pardon only, but even to our admiration, however loosely they may hang upon the fable. All these three ends are effected by that most beautiful episode of Hector and Andromache in the sixth book of the Iliad; and the two last, by the no less beautiful one of Euryalus and Nisus in the ninth of the Æneid.

IV. And now, from the position formerly established, that the end of this divine art is to give pleasure, it has been endeavoured to prove, that, whether in displaying the appearances of the material universe, or in imitating the workings of the human mind, and the varieties of human character, or in arranging and combining into one whole the several incidents and parts whereof his fable consists,—the aim of the poet must be to copy nature, not as it is, but in that state of perfection in which, consistently with the particular genius of the work, and the laws of verisimilitude, it may be supposed to be.

Arist. et.

Martial.

40
nature al-
ways to be
improved
y the poet
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Such, in general, is the nature of that poetry which is intended to raise admiration, pity, and other serious emotions. But in this art, as in all others, there are different degrees of excellence; and we have hitherto directed our view chiefly to the highest. All serious poets are not equally solicitous to improve nature. Euripides is said to have represented men as they were; Sophocles, more poetically, as they should or might be †. Theocritus in his Idyls, and Spencer in his Shepherd's Calendar, give us language and sentiments more nearly approaching those of the *Rus verum et barbarum* ‡, than what we meet with in the Pastorals of Virgil and Pope. In the historical drama, human characters and events must be according to historical truth, or at least not so remote from it as to lead into any important misapprehension of fact. And in the historical epic poem, such as the Pharsalia of Lucan, and the Campaign of Addison, the historical arrangement is preferred to the poetical, as being nearer the truth. Yet nature is a little improved even in these poems. The persons in Shakespeare's historical plays, and the heroes of the Pharsalia, talk in verse, and suitably to their characters, and with

Vol. XV. Part I.

a readiness, beauty, and harmony of expression, not to be met with in real life, nor even in history: speeches are invented, and, to heighten the description, circumstances added, with great latitude: real events are rendered more compact and more strictly dependent upon one another; and fictitious ones brought in, to elucidate human characters and diversify the narration.

The more poetry improves nature, by copying after general ideas collected from extensive observation, the more it partakes (according to Aristotle) of the nature of philosophy; the greater stretch of fancy and of observation it requires in the artist, the better chance it has to be universally agreeable.

Yet poetry, when it falls short of this perfection, may have great merit as an instrument of both instruction and pleasure. To most men, simple unadorned nature is, at certain times, and in certain compositions, more agreeable than the most elaborate improvements of art; as a plain short period, without modulation, gives a pleasing variety to a discourse. Many such portraits of simple nature there are in the subordinate parts both of Homer's and of Virgil's poetry: and an excellent effect they have in giving probability to the fiction, as well as in gratifying the reader's fancy with images distinct and lively, and easily comprehended. The historical plays of Shakespeare raise not our pity and terror to such a height as Lear, Macbeth, or Othello; but they interest and instruct us greatly notwithstanding. The rudest of the eclogues of Theocritus, or even of Spenser, have by some authors been extolled above those of Virgil, because more like real life. Nay, Corneille is known to have preferred the Pharsalia to the Æneid, perhaps from its being nearer the truth, or perhaps from the sublime sentiments of stoical morality so forcibly and so ostentatiously displayed in it.

41

When poetry falls short of this perfection it may have great merit in other respects.

Poets may refine upon nature too much as well as too little; for affectation and rusticity are equally remote from true elegance. The style and sentiments of comedy should no doubt be more correct and more pointed than those of the most polite conversation: but to make every footman a wit, and every gentleman and lady an epigrammatist, as Congreve has done, is an excessive and faulty refinement. The proper medium has been hit by Menander and Terence, by Shakespeare in his happier scenes, and by Garrick, Cumberland, and some others of late renown. To describe the passion of love with as little delicacy as some men speak of it would be unpardonable; but to transform it into mere Platonic adoration is to run into another extreme, less criminal indeed, but too remote from universal truth to be universally interesting. To the former extreme Ovid inclines, and Petrarch and his imitators to the latter. Virgil has happily avoided both: but Milton has painted this passion as distinct from all others, with such peculiar truth and beauty, that we cannot think Voltaire's encomium too high, when he says, that love in all other poetry seems a weakness, but in Paradise Lost a virtue. There are many good strokes of nature in Ramsay's Gentle Shepherd; but the author's passion for the *rus verum* betrays him into some indelicacies: a censure that falls with greater weight upon Theocritus, who is often absolutely indecent. The Italian pastoral of Tasso and Guarini, and the French of Fontenelle, run into the opposite extreme (though in some parts beautifully simple), and display a system of rural manners so quaint

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Of Poetical Language.

Of Poetical Words.

and affected as to outrage all probability. In fine, though mediocrity of execution in poetry be allowed to deserve the doom pronounced upon it by Horace; yet it is true, notwithstanding, that in this art, as in many other good things, the point of excellence lies in a middle between two extremes; and has been reached by those only who fought to improve nature as far as the genius of their work would permit, keeping at an equal distance from rusticity on the one hand, and affected elegance on the other.

SECT. VI. Of Poetical Language.

42
Words in poetry to be chosen for their sense and for their sound.

WORDS in poetry are chosen, first, for their *sense*; and, secondly, for their *sound*. That the first of these grounds of choice is the more excellent nobody can deny. He who in literary matters prefers sound to sense is a fool. Yet sound is to be attended to even in prose, and in verse demands particular attention. We shall consider poetical language, first, as SIGNIFICANT; and, secondly, as SUSCEPTIBLE OF HARMONY.

§ I. Of Poetical Language considered as SIGNIFICANT.

43
The language of poetry an imitation of the language of nature.

IF, as it has been endeavoured to prove, poetry be imitative of nature, poetical fictions of real events, poetical images of real appearances in the visible creation, and poetical personages of real human characters; it would seem to follow, that the *language of poetry* must be an imitation of the *language of nature*.

* Essays, Part ii. chap. 1.

According to Dr Beattie *, that language is natural which is suited to the speaker's condition, character, and circumstances. And as, for the most part, the images and sentiments of serious poetry are copied from the images and sentiments, not of real, but of improved, nature; so the language of serious poetry must (as hinted already) be a transcript, not of the real language of nature, which is often dissonant and rude, but of natural language improved as far as may be consistent with probability, and with the supposed character of the speaker. If this be not the case, if the language of poetry be such only as we hear in conversation or read in history, it will, instead of delight, bring disappointment: because it will fall short of what we expect from an art which is recommended rather by its pleasurable qualities than by its intrinsic utility; and to which, in order to render it pleasing, we grant higher privileges than to any other kind of literary composition, or any other mode of human language.

44
Improved as far as may be consistent with probability.

The next inquiry must therefore be, "What are those improvements that peculiarly belong to the language of poetry?" And these may be comprehended under two heads; *poetical words*, and *tropes and figures*.

Art. I. Of Poetical WORDS.

45
All languages have words peculiar to poetry.

One mode of improvement peculiar to poetical diction results from the use of those words and phrases which, because they rarely occur in prose, and frequently in verse, are by the grammarian and lexicographer termed *poetical*. In these some languages abound more than others; but no language perhaps is altogether without them, and perhaps no language can be so in which any number of good poems have been written: for poetry is better remembered than prose, especially by poetical authors, who will always be apt to imitate the phraseology of those they have been accustomed to read and

admire; and thus, in the works of poets down through successive generations, certain phrases may have been conveyed, which, though originally perhaps in common use, are now confined to poetical composition. Prose writers are not so apt to imitate one another, at least in words and phrases, both because they do not so well remember one another's phraseology, and also because their language is less artificial, and must not, if they would make it easy and flowing (without which it cannot be elegant), depart essentially from the style of correct conversation. Poets, too, on account of the greater difficulty of their numbers, have, both in the choice and in the arrangement of words, a better claim to indulgence, and stand more in need of a discretionary power.

The language of Homer differs materially from what was written and spoken in Greece in the days of Socrates. It differs in the mode of inflection, it differs in the syntax, it differs even in the words: so that one might read Homer with ease who could not read Xenophon; or Xenophon, without being able to read Homer. Yet we cannot believe that Homer, or the first Greek poet who wrote in his style, would make choice of a dialect quite different from what was intelligible in his own time: for poets have in all ages written with a view to be read, and to be read with pleasure; which they could not be if their diction were hard to be understood. It is more reasonable to suppose that the language of Homer is according to some ancient dialect, which, though not perhaps in familiar use among the Greeks at the time he wrote, was however intelligible. From the Homeric to the Socratic age, a period had elapsed of no less than 400 years; during which the style both of discourse and of writing must have undergone great alterations. Yet the *Iliad* continued the standard of heroic poetry, and was considered as the very perfection of poetical language; notwithstanding that some words in it were become so antiquated, or so ambiguous, that Aristotle himself seems to have been somewhat doubtful in regard to their meaning *. And * Poetis if Chaucer's merit as a poet had been as great as Ho-cap. 25-mer's, and the English tongue under Edward III. as perfect as the Greek was in the second century after the Trojan war, the style of Chaucer would probably have been our model for poetical diction at this day; even as Petrarch, his contemporary, is still imitated by the best poets of Italy.

The rudeness of the style of Ennius has been imputed by the old critics to his having copied too closely the dialect of common life. But this appears to be a mistake. For if we compare the fragments of that author with the comedies of Plautus, who flourished in the same age, and whose language was certainly copied from that of common life, we shall be struck with an air of antiquity in the former that is not in the latter. Ennius, no doubt, like most other sublime poets, affected something of the antique in his expression: and many of his words and phrases, not adopted by any prose-writer now extant, are to be found in Lucretius and Virgil, and were by them transmitted to succeeding poets. These form part of the Roman poetical dialect; which appears from the writings of Virgil, where we have it in perfection, to have been very copious. The style of this charming poet is indeed so different that of from prose, and is altogether so peculiar, that it is per-rose.haps impossible to analyse it on the common principles of

46
The poetical dialect different from prose.

Of poetical words. of Latin grammar. And yet no author can be more perspicuous or more expressive; notwithstanding the frequency of Grecism in his syntax, and his love of old words, which he, in the judgment of Quintilian, knew better than any other man how to improve into decoration*.

* *lit.*
viii. § 3. The poetical dialect of modern Italy is so different from the prosaic, that persons who can read the historians, and even speak with tolerable fluency the language of that country, may yet find it difficult to construe a page of Petrarch or Tasso. Yet it is not probable, that Petrarch, whose works are a standard of the Italian poetical diction †, made any material innovations in his native tongue. It is rather probable that he wrote it nearly as it was spoken in his time, that is, in the 14th century; omitting only harsh combinations, and taking that liberty which Homer probably, and Virgil certainly, took before him, of reviving such old, but not obsolete expressions, as seemed peculiarly significant and melodious; and polishing his style to that degree of elegance which human speech, without becoming unnatural, may admit of, and which the genius of poetry, as an art subservient to pleasure, may be thought to require.

The French poetry in general is distinguished from prose rather by the rhyme and the measure, than by any old or uncommon phraseology. Yet the French, on certain subjects, imitate the style of their old poets, of Marot in particular; and may therefore be said to have something of a poetical dialect, though far less extensive than the Italian, or even than the English. And it may be presumed, that in future ages they will have more of this dialect than they have at present. This may be inferred from the very uncommon merit of some of their late poets, particularly Boileau and La Fontaine, who, in their respective departments, will continue to be imitated, when the present modes of French prose are greatly changed: an event that, for all the pains they take to preserve their language, must inevitably happen, and whereof there are not wanting some presages already.

The English poetical dialect is not characterised by any peculiarities of inflection, nor by any great latitude in the use of foreign idioms. More copious it is, however, than one would at first imagine; as may appear from the following specimen and observations.

(1.) A few Greek and Latin idioms are common in English poetry, which are seldom or never to be met with in prose. QUENCHED OF HOPE. Shakespeare.—SHORN OF HIS BEAMS. Milton.—*Created thing* NOR VALUED HE NOR SHUN'D. Milton.—*'Tis thus we riot, while who sow it starve.* Pope.—*This day BE BREAD AND PEACE MY LOT.* Pope.—*INTO WHAT PIT THOU SEE'ST FROM WHAT HEIGHT FALLEN.* Milton.—*He deceived The mother of mankind, WHAT TIME HIS PRIDE HAD CAST HIM out of heaven.* Milton.—Some of these, with others to be found in Milton, seem to have been adopted for the sake of brevity, which in the poetical tongue is indispensable. For the same reason, perhaps the articles *a* and *the* are sometimes omitted by our poets, though less frequently in serious than burlesque composition.—In English, the adjective generally goes before the substantive, the nominative before the verb, and the active verb before (what we call) the accusative. Exceptions, however,

to this rule, are not uncommon even in prose. But Of Poetical Words. in poetry they are more frequent. *Their homely joys, and DESTINY OBSCURE.* Now fades the glimmering landscape on the sight; and all the air a solemn stillness holds. In general, that versification may be less difficult, and the cadence more uniformly pleasing; and sometimes, too, in order to give energy to expression, or vivacity to an image;—the English poet is permitted to take much greater liberties than the prose-writer, in arranging his words, and modulating his lines and periods. Examples may be seen in every page of Paradise Lost.

(2.) Some of our poetical words take an additional syllable, that they may suit the verse the better; as, *disport, disdain, disport, affright, encchain*, for part, flain, sport, fright, chain. Others seem to be nothing else than common words made shorter, for the convenience of the versifier. Such are, *auxiliar, sublunar, trump, vale, part, clime, submit, frolic, plain, drear, dread, helm, morn, mead, eve and even, gan, illumine and illumine, ope, hoar, bide, savage, scape*; for auxiliary, sublunary, trumpet, valley, depart, climate, submissive, frolicsome, complain, dreary, dreadful, helmet, morning, meadow, evening, began or began to, illuminate, open, hoary, abide, assuage, escape.—Of some of these the short form is the more ancient. In Scotland, *even, morn, bide, savage*, are still in vulgar use; but *morn*, except when contradistinguished to *even*, is synonymous, not with *morning* (as in the English poetical dialect), but with *morrow*.—The Latin poets, in a way somewhat similar, and perhaps for a similar reason, shortened *fundamentum, tutamentum, munimentum*, &c. into *fundamen, tutamen, munimen*.

(3.) Of the following words, which are now almost peculiar to poetry, the greater part are ancient, and were once no doubt in common use in England, as many of them still are in Scotland. *Afield, amain, annoy* (a noun), *anon, aye* (ever), *behest, blithe, brand* (sword), *bridal, carol, dame* (lady), *fealty, fell* (an adjective), *gaude, gore, host* (army), *lumbkin, late* (of late), *lay* (poem), *lea, glade, gleam, hur', lorn, meed, orisons, plod* (to travel laboriously), *ringlet, rue* (a verb), *ruth, rutblest, sojourn* (a noun), *smite, spend* (an active verb), *save* (except), *spray* (twig), *steed, strain* (song), *strand, swain, thrall, thrill, trail* (a verb), *troll, wel, welter, warble, wayward, woo, the while* (in the mean time), *yon, of yore*.

(4.) These that follow are also poetical; but, so far as appears, were never in common use. *Appal, arrowy, attune, battailous, breezy, car* (chariot), *clarion, cates, courser, darkling, flicker, floweret, emblaze, gairish, circlet, impearl, nightly, noiseless, pinion* (wing), *shadowy, slumberous, streamy, troublous, wilder* (a verb), *shrill* (a verb), *shook* (shaken), *madding, viewless*.—The following, too, derived from the Greek and Latin, seem peculiar to poetry. *Clang, clangor, choral, bland, boreal, dire, ensanguined, ire, ireful, lave* (to wash), *nymph* (lady, girl), *orient, panoply, philomel, insuriate, jocund, radiant, rapt, redolent, resplendent, verdant, vernal, zephyr, zone* (girdle), *sylvan, suffuse*.

(5.) In most languages, the rapidity of pronunciation abbreviates some of the commonest words, or even joins two, or perhaps more, of them, into one; and some of those abbreviated forms find admission into writing. The English language was quite disfigured by

Of Poetical
Words.

them in the end of the last century; but Swift, by his satire and example, brought them into disrepute: and, though some of them be retained in conversation, as *don't, shan't, can't*, they are now avoided in solemn style; and by elegant writers in general, except where the colloquial dialect is imitated, as in comedy. 'Tis and 'twas, since the time of Shaftesbury, seem to have been daily losing credit, at least in prose; but still have a place in poetry, perhaps because they contribute to conciseness. 'Twas on a lofty waste's side. Gray.—'Tis true, 'tis certain, man, though dead, retains part of himself. Pope. In verse too, *over* may be shortened into *o'er*, (which is the Scotch, and probably was the old English, pronunciation); *never* into *ne'er*; and from *the* and *to*, when they go before a word beginning with a vowel, the final letter is sometimes cut off. *O'er hills, o'er dales, o'er crags, o'er rocks they go.* Pope.—*Where'er she turns, the Graces homage pay. And all that beauty, all that wealth e'er gave. Rich with the spoils of time did ne'er unroll.* Gray.—*T'alarm th' eternal midnight of the grave.*—These abbreviations are now peculiar to the poetical tongue, but not necessary to it. They sometimes promote brevity, and render versification less difficult.

(6.) Those words which are commonly called *compound epithets*, as *rosy-finger'd, rosy-bosom'd, many-twinkling, many-sounding, moss-grown, bright-eyed, straw-built, spirit-stirring, incense-breathing, heaven-taught, love-whispering, lute-resounding*, are also to be considered as part of our poetical dialect. It is true, we have compound adjectives in familiar use, as *high-seasoned, well-natured, ill-bred*, and innumerable others. But we speak of those that are less common, that seldom occur except in poetry, and of which in prose the use would appear affected. And that they sometimes promote brevity and vivacity of expression, cannot be denied. But as they give, when too frequent, a stiff and finical air to a performance; as they are not always explicit in the sense, nor agreeable in the sound; as they are apt to produce a confusion, or too great a multiplicity, of images; as they tend to disfigure the language, and furnish a pretext for endless innovation; they ought to be used sparingly; and those only used which the practice of popular authors has rendered familiar to the ear, and which are in themselves peculiarly emphatical and harmonious.

(7.) In the transformation of nouns into verbs and participles, our poetical dialect admits of greater latitude than prose. Hymn, pillow, curtain, story, pillar, picture, peal, surge, cavern, honey, career, cincture, bosom, sphere, are common nouns; but to *hymn, to pillow, curtain'd, pillared, pictured, pealing, surging, cavern'd, bonied, careering, cinctured, bosomed, sphered*, would appear affected in prose, and yet in verse they are warranted by great authorities, though it must be confessed that they are censured by an able critic*, who had studied the English language, both poetical and prosaic, with wonderful diligence.

Some late poets, particularly the imitators of Spenser, have introduced a great variety of uncommon words,

as *certes, estfoons, ne, whilom, transnew, moil, fone, losel, albe, hight, dight, pight, thews, couthful, assot, muchel, wend, arrear, &c.* These were once poetical words, no doubt; but they are now obsolete, and to many readers unintelligible. No man of the present age, however conversant in this dialect, would naturally express himself in it on any interesting emergence; or, supposing this natural to the antiquarian, it would never appear so to the common hearer or reader. A mixture of these words, therefore, must ruin the pathos of modern language; and as they are not familiar to our ear, and plainly appear to be fought after and affected, will generally give a stiffness to modern versification. Yet in subjects approaching to the ludicrous they may have a good effect; as in the *Schoolmistress* of Shenstone, Parnel's Fairy-tale, Thomson's *Castle of Indolence*, and Pope's lines in the *Dunciad* upon Wormius. But this effect will be most pleasing to those who have least occasion to recur to the glossary.

Indeed, it is not always easy to fix the boundary between poetical and obsolete expressions. To many readers, *lore, meed, behest, blithe, gaude, spray, thrall*, may already appear antiquated; and to some the style of Spencer, or even of Chaucer, may be as intelligible as that of Dryden. This however we may venture to affirm, that a word, which the majority of readers cannot understand without a glossary, may with reason be considered as obsolete; and ought not to be used in modern composition, unless revived, and recommended to the public ear, by some very eminent writer. There are but few words in Milton, as *nathless, tine, frore, bosky, &c.*; there are but one or two in Dryden, as *falsify* (F); and in Pope, there are none at all, which every reader of our poetry may not be supposed to understand: whereas in Shakespeare there are many, and in Spencer many more, for which one who knows English very well may be obliged to consult the dictionary. The practice of Milton, Dryden, or Pope, may therefore, in almost all cases, be admitted as good authority for the use of a poetical word. And in them, all the words above enumerated, as poetical, and in present use, may actually be found. And of such poets as may choose to observe this rule, it will not be said, either that they reject the judgment of Quintilian, who recommends the newest of the old words, and the oldest of the new, or that they are inattentive to Pope's precept;

Be not the first by whom the new are tried,
Nor yet the last to lay the old aside.

Eff. on Crit. v. 335.

We must not suppose that these poetical words never occur at all except in poetry. Even from conversation they are not excluded: and the ancient critics allow, that they may be admitted into prose, where they occasionally confer dignity upon a sublime subject, or heighten the ludicrous qualities of a mean one. But it is in poetry only where the frequent use of them does not favour of affectation.

Nor must we suppose them essential to this art.
Many

(F) Dryden in one place (*Æneid* ix. vers. 1095.) uses *Falsified* to denote *Pierced through and through*. He acknowledges, that this use of the word is an innovation; and has nothing to plead for it but his own authority, and that *Falsure* in Italian sometimes means the same thing.

48
To be used
sparingly.

* Johnson.

Of Poetical Words

Many passages there are of exquisite poetry, wherein not a single phrase occurs that might not be used in prose. In fact, the influence of these words in adorning English verse is not very extensive. Some influence however they have. They serve to render the poetical style, first, more melodious; and, secondly, more solemn.

49
In which
case they
may ren-
der the
poetical
style more
melodious

First, They render the poetical style more melodious, and more easily reducible into measure. Words of unwieldy size, or difficult pronunciation, are never used by correct poets, where they can be avoided: unless in their sound they have something imitative of the sense. Homer's poetical inflections contribute wonderfully to the sweetness of his numbers: and if the reader is pleased to look back to the specimen above given of the English poetical dialect, he will find that the words are in general well-sounding, and such as may coalesce with other words, without producing harsh combinations. Quintilian observes, that poets, for the sake of their verse, are indulged in many liberties, not granted to the orator, of lengthening, shortening, and dividing their words*:—and if the Greek and Roman poets claimed this indulgence from necessity, and obtained it, the English, those of them especially who write in rhyme, may claim it with better reason; as the words of their language are less musical and far less susceptible of variety in arrangement and syntax.

* Instit.
Orat. lib.
10. cap. 1
§ 3.

50
And so-
lemn.

Secondly, Such poetical words as are known to be ancient have something venerable in their appearance, and impart a solemnity to all around them. This remark is from Quintilian; who adds, that they give to a composition that cast and colour of antiquity which in painting is so highly valued, but which art can never effectually imitate†. Poetical words that are either not ancient, or not known to be such, have, however, a pleasing effect from association. We are accustomed to meet with them in sublime and elegant writing; and hence they come to acquire sublimity and elegance: Even as the words we hear on familiar occasions come to be accounted familiar; and as those that take their rise among pick-pockets, gamblers, and gypsies, are thought too indelicate to be used by any person of taste or good manners. When one hears the following lines, which abound in poetical words,

The breezy call of incense-breathing morn,
The swallow twittering from the straw-built shed,
The cock's shrill clarion, or the echoing horn,
No more shall rouse them from their lowly bed:

—one is as sensible of the dignity of the language, as one would be of the vileness or vulgarity of that man's speech, who should prove his acquaintance with Bridewell, by interlarding his discourse with such terms as *mill-doll*, *queer cull*, or *rubbing cheat*‡; or who, in imitation of fops and gamblers, should on the common occasions of life, talk of being *beat hollow*, or *saving his distance*§. What gives dignity to persons gives dignity to language. A man of this character is one who has borne important employments, been connected with honourable associates, and never degraded himself by levity or immorality of conduct. Dignified phrases are those which have been used to express elevated sentiments, have always made their appearance in elegant composition, and have never been profaned by giving permanency or utterance to the passions of the vile, the giddy, or the worthless. And

‡ See the
Scoundrel's
Dictionary.
§ Language
of New-
market.

as by an active old age, the dignity of such men is confirmed and heightened; so the dignity of such words, if they be not suffered to fall into disuse, seldom fails to improve by length of time.

Art. II. Of Tropes and Figures.

If it appear that, by means of figures, language may be made more *pleasing* and more natural than it would be without them; it will follow, that to poetic language, whose end is to *please* by imitating *nature*, figures must be not only ornamental, but necessary. It will here be proper, therefore, first to point out the importance and utility of figurative language; secondly, to show, that figures are more necessary to poetry in general than to any other mode of writing.

I. *As to the importance and utility of figurative expression*, in making language more pleasing and more natural; it may be remarked,

(1.) That tropes and figures are often necessary to supply the unavoidable defects of language. When proper words are wanting, or not recollected, or when we do not choose to be always repeating them, we must have recourse to tropes and figures. When philosophers began to explain the operations of the mind, they found that most of the words in common use, being framed to answer the more obvious exigencies of life, were in their proper signification applicable to matter only and its qualities. What was to be done in this case? Would they think of making a new language to express the qualities of mind? No: that would have been difficult or impracticable; and granting it both practicable and easy, they must have foreseen, that nobody would read or listen to what was thus spoken or written in a new and consequently in an unknown tongue. They therefore took the language as they found it; and wherever they thought there was a similarity or analogy between the qualities of the mind and the qualities of matter, scrupled not to use the names of the material qualities tropically, by applying them to the mental qualities. Hence came the phrases *solidity* of judgment, *warmth* of imagination, *enlargement* of understanding, and many others; which, though figurative, express the meaning just as well as proper words would have done. In fact, numerous as the words in every language are, they must always fall short of the unbounded variety of human thoughts and perceptions. Tastes and smells are almost as numerous as the species of bodies. Sounds admit of perceptible varieties that surpass all computation, and the seven primary colours may be diversified without end. If each variety of external perception were to have a name, language would be insurmountably difficult; nay, if men were to appropriate a class of names to each particular sense, they would multiply words exceedingly, without adding any thing to the clearness of speech. Those words, therefore, that in their proper signification denote the objects of one sense, we often apply tropically to the objects of another, and say, Sweet taste, sweet smell, sweet sound; sharp point, sharp taste, sharp sound; harmony of sounds, harmony of colours, harmony of parts; soft silk, soft colour, soft sound, soft temper; and so in a thousand instances: and yet these words, in their tropical signification, are not less intelligible than in their proper one; for sharp taste and sharp sound, are as expressive as sharp sword; and harmony of tones is not better understood by the musician, than har-

Of Tropes and Figures.

51
Tropes and
Figures ne-
cessary to
poetical
language.

52
To supply
the defects
of simple
language,
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mony

Of Tropes many of parts by the architect, and harmony of colours
an' Figures by the painter.

Savages, illiterate persons, and children, have comparatively but few words in proportion to the things they may have occasion to speak of; and must therefore recur to tropes and figures more frequently than persons of copious elocution. A seaman, or mechanic, even when he talks of that which does not belong to his art, borrows his language from that which does; and this makes his diction figurative to a degree that is sometimes entertaining enough. "Death (says a seaman in one of Smollet's novels) has not yet *boarded* my comrade; but they have been *yard arm and yard-arm* these *three glasses*. His *starboard* eye is open, but fast *jammed* in his head; and the *haulyards* of his under jaw have given way." These phrases are exaggerated; but we allow them to be natural, because we know that illiterate people are apt to make use of tropes and figures taken from their own trade, even when they speak of things that are very remote and incongruous. In those poems, therefore, that imitate the conversation of illiterate persons, as in comedy, farce, and pastoral, such figures judiciously applied may render the imitation more pleasing, because more exact and natural.

53
To avoid
harshness
of diction.

Words that are untuneable and harsh, the poet is often obliged to avoid, when perhaps he has no other way to express their meaning than by tropes and figures; and sometimes the measure of his verse may oblige him to reject a proper word that is not harsh, merely on account of its being too long, or too short, or in any other way unsuitable to the rhythm, or to the rhyme. And hence another use of figurative language, that it contributes to poetical harmony. Thus, *to press the plain*, is frequently used to signify *to be slain in battle*; *liquid plain* is put for *ocean*, *blue serene* for *sky*, and *sylvan* for *country life*.

54
Tropes and
figure: fa-
vourable
to delicacy.

(2.) Tropes and figures are favourable to delicacy. When the proper name of a thing is in any respect unpleasant, a well-chosen trope will convey the idea in such a way as to give no offence. This is agreeable, and even necessary, in polite conversation, and cannot be dispensed with in elegant writing of any kind. Many words, from their being often applied to vulgar use, acquire a meanness that disqualifies them for a place in serious poetry; while perhaps, under the influence of a different system of manners, the corresponding words in another language may be elegant, or at least not vulgar. When one reads Homer in the Greek, one takes no offence at his calling Eumeus by a name which, literally rendered, signifies *swine-herd*; first, because the Greek word is well-sounding in itself; secondly, because we have never heard it pronounced in conversation, nor consequently debased by vulgar use; and, thirdly, because we know, that the office denoted by it was, in the age of Eumeus, both important and honourable. But Pope would have been blamed, if a name so indelicate as *swine-herd* had in his translation been applied to so eminent a personage; and therefore he judiciously makes use of the trope *synechdoche*, and calls him *swain**; a word both elegant and poetical, and not likely to lead the reader into any mistake about the person spoken of, as his employment had been described in a preceding passage. The same Eumeus is said, in the simple but melodious language of the original, to have been making his own shoes when Ulysses came to his door; a work

which in those days the greatest heroes would often find necessary. This, too, the translator softens by a tropical expression:

Here sat Eumeus, and his cares applied,
To form strong *bykins* of well season'd hide.

A hundred other examples might be quoted from this translation; but these will explain our meaning.

There are other occasions on which the delicacy of figurative language is still more needful; as in Virgil's account of the effects of animal love, and of the plague among the beasts, in the third Georgic; where Dryden's style, by being less figurative than the original, is in one place exceedingly filthy, and in another shockingly obscene.

Hobbes could construe a Greek author; but his skill in words must have been all derived from the dictionary; for he seems not to have known that any one articulate sound could be more agreeable, or any one phrase more dignified, than another. In his *Iliad* and *Odyssey*, even when he hits the author's sense (which is not always the case), he proves, by his choice of words, that of harmony, elegance, or energy of style, he had no manner of conception. And hence that work, though called a *Translation of Homer*, does not even deserve the name of *poem*; because it is in every respect unpleasing, being nothing more than a fictitious narrative delivered in a mean prose, with the additional meanness of harsh rhyme, and untuneable measure. — Trapp understood Virgil well enough as a grammarian, and had a taste for his beauties: yet his translation bears no resemblance to Virgil; which is owing to the same cause, an imprudent choice of words and figures, and a total want of harmony.

The delicacy we here contend for, may indeed, both in conversation and in writing, be carried too far. To call *killing an innocent man in a duel* an affair of honour, and a *violation of the rights of wedlock* an affair of gallantry, is a prostitution of figurative language. Nor is it any credit to us, that we are said to have upwards of 40 figurative phrases to denote excessive drinking. Language of this sort generally implies, that the public abhorrence of such crimes is not so strong as it ought to be; and it is a question, whether even our morals might not be improved, if we were to call these and such like crimes by their proper names, *murder*, *adultery*, *drunkenness*, *gluttony*; names, that not only express our meaning, but also betoken our disapprobation. — As to writing, it cannot be denied, that even Pope himself, in the excellent version just now quoted, has sometimes, for the sake of his numbers, or for fear of giving offence by too close an imitation of Homer's simplicity, employed tropes and figures too quaint or too solemn for the occasion. And the finical style is in part characterised by the writer's dislike to literal expressions, and affectedly substituting in their stead unnecessary tropes and figures. With these authors, a man's only child must always be his *only hope*; a country maid becomes a *rural beauty*, or perhaps a *nymph of the groves*; if flattery sing at all, it must be a *syren song*; the shepherd's flute dwindles into an *oaten reed*, and his crook is exalted into a *sceptre*; the *silver lilies* rise from their *golden beds*, and *languish* to the *complaining* gale. A young woman, though a good Christian, cannot make herself agreeable without *sacrificing to the Graces*; nor

55
Which,
however,
may be car-
ried too far.

* *Odysf.*
b. 14.
v. 41.

Of Tropes
and Fi-
gures.

Of Tropes
and Fi-
gures.

36
ropes and
gure pro-
mote bre-
vity, and

57
tribute
strength
and energy
language.

hope to do any execution among the *gentle swains*, till a whole legion of *Cupids*, armed with *flames and darts*, and other weapons, begin to discharge from her eyes their formidable artillery. For the sake of variety, or of the verse, some of these figures may now and then find a place in a poem; but in prose, unless very sparingly used, they favour of affectation.

(3.) Tropes and figures promote brevity; and brevity, united with perspicuity, is always agreeable. An example or two will be given in the next paragraph. Sentiments thus delivered, and imagery thus painted, are readily apprehended by the mind, make a strong impression upon the fancy, and remain long in the memory; whereas too many words, even when the meaning is good, never fail to bring disgust and weariness. They argue a debility of mind which hinders the author from seeing his thoughts in one distinct point of view; and they also encourage a suspicion, that there is something faulty or defective in the matter. In the poetic style, therefore, which is addressed to the fancy and passions, and intended to make a vivid, a pleasing, and a permanent impression, brevity, and consequently tropes and figures, are indispensable. And a language will always be the better suited to poetical purposes, the more it admits of this brevity;—a character which is more conspicuous in the Greek and Latin than in any modern tongue, and much less in the French than in the Italian or English.

(4.) Tropes and figures contribute to strength or energy of language, not only by their conciseness, but also by conveying to the fancy ideas that are easily comprehended, and make a strong impression. We are powerfully affected with what we see, or feel, or hear. When a sentiment comes enforced or illustrated by figures taken from objects of sight, or touch, or hearing, one thinks, as it were, that one sees, or feels, or hears, the thing spoken of; and thus, what in itself would perhaps be obscure, or is merely intellectual, may be made to seize our attention and interest our passions almost as effectually as if it were an object of outward sense. When Virgil calls the Scipios *thunderbolts of war*, he very strongly expresses in one word, and by one image, the rapidity of their victories, the noise their achievements made in the world, and the ruin and consternation that attended their irresistible career. — When Homer calls Ajax *the bulwark of the Greeks*, he paints with equal brevity his vast size and strength, the difficulty of prevailing against him, and the confidence wherewith his countrymen reposed on his valour. — When Solomon says of the strange woman, or harlot, that “her feet go down to death,” he lets us know, not only that her path ends in destruction, but also, that they who accompany her will find it easy to go forwards to ruin, and difficult to return to their duty. — Satan’s enormous magnitude, and refulgent appearance, his perpendicular ascent through a region of darkness, and the inconceivable rapidity of his motion, are all painted out to our fancy by Milton, in one very short similitude,

Sprung upward, like—a pyramid of fire.

Par. Lost, b. 4. v. 1013.

To take in the full meaning of which figure, we must imagine ourselves in chaos, and a vast luminous body rising upward, near the place where we are, so swiftly as to appear a continued track of light, and lessening

to the view according to the increase of distance, till it end in a point, and then disappear; and all this must be supposed to strike our eye at one instant. — Equal to this in propriety, though not in magnificence, is that allegory of Gray,

The paths of glory lead but to the grave:

Which presents to the imagination a wide plain, where several roads appear, crowded with glittering multitudes, and issuing from different quarters, but drawing nearer and nearer as they advance, till they terminate in the dark and narrow house, where all their glories enter in succession, and disappear for ever. — When it is said in Scripture, of a good man who died, that he *fell asleep*, what a number of ideas are at once conveyed to our imagination, by this beautiful and expressive figure: As a labourer, at the close of day, goes to sleep, with the satisfaction of having performed his work, and with the agreeable hope of awaking in the morning of a new day, refreshed and cheerful; so a good man, at the end of life, resigns himself calm and contented to the will of his Maker, with the sweet reflection of having endeavoured to do his duty, and with the transporting hope of soon awaking in the regions of light, to life and happiness eternal. The figure also suggests, that to a good man the transition from life to death is, even in the sensation, no more painful, than when our faculties melt away into the pleasing insensibility of sleep. — Satan, flying among the stars, is said by Milton to “*sail* between worlds and worlds;” which has an elegance and force far superior to the proper word *fly*. For by this allusion to a ship, we are made to form a lively idea of his great size, and to conceive of his motion, that it was equable and majestic. — Virgil uses a happy figure to express the size of the great wooden horse, by means of which the Greeks were conveyed into Troy: “*Equum divina Palladis arte ædificant.*” — Milton is still bolder when he says,

Who would not sing for Lycidas? he knew
Himself to sing, and *build the lofty rhyme*.

The phrase, however, though bold, is emphatical; and gives a noble idea of the durability of poetry, as well as of the art and attention requisite to form a good poem. — There are hundreds of tropical expressions in common use, incomparably more energetic than any proper words of equal brevity that could be put in their place. A cheek *burning* with blushes, is a trope which at once describes the colour as it appears to the beholder, and the glowing heat as it is felt by the person blushing. *Chilled* with despondence, *petrified* with astonishment, *thunderstruck* with disagreeable and unexpected intelligence, *melted* with love or pity, *dissolved* in luxury, *hardened* in wickedness, *softening* into remorse, *inflamed* with desire, *tossed* with uncertainty, &c.—every one is sensible of the force of these and the like phrases, and that they must contribute to the energy of composition.

(5.) Tropes and figures promote strength of expression; They are and are in poetry peculiarly requisite, because they are likewise often more *natural*, and more *imitative*, than proper words. In fact, this is so much the case, that it would be impossible to imitate the language of passion without them. It is true, that when the mind is agitated, one does not run out into allegories, or long-winded similitudes, or any of the figures that require much attention; and

Of Tropes
and Fi-
gures.

and many words, or that tend to withdraw the fancy from the object of the passion. Yet the language of many passions must be figurative notwithstanding; because they rouse the fancy, and direct it to objects congenial to their own nature, which diversify the language of the speaker with a multitude of allusions. The fancy of a very angry man, for example, presents to his view a train of disagreeable ideas connected with the passion of anger, and tending to encourage it; and if he speak without restraint during the paroxysm of his rage, those ideas will force themselves upon him, and compel him to give them utterance. "Infernal monster! (he will say),—my blood boils at him; he has used me like a dog; never was man so injured as I have been by this barbarian." He has no more sense of propriety than a stone. His countenance is diabolical, and his soul as ugly as his countenance. His heart is cold and hard, and his resolutions dark and bloody," &c. This speech is wholly figurative. It is made up of *metaphors* and *hyperboles*, which, with the *prosopeia* and *apostrophe*, are the most passionate of all the figures. Lear, driven out of doors by his unnatural daughters, in the midst of darkness, thunder, and tempest, naturally breaks forth (for his indignation is just now raised to the very highest pitch) into the following violent exclamation against the crimes of mankind, in which almost every word is figurative.

Tremble, thou wretch,
That hast within thee undivulged crimes
Unwhipt of justice. Hide thee, thou bloody hand,
Thou perjur'd, and thou simular of virtue,
That art incestuous. Caitiff, to pieces shake,
That under covert, and convenient seeming,
Hast practis'd on man's life. Close pent-up guilts,
Rive your concealing continents, and cry
These dreadful summoners grace. *King Lear.*

—The vehemence of maternal love, and sorrow from the apprehension of losing her child, make the Lady Constance utter a language that is strongly figurative, though quite suitable to the condition and character of the speaker. The passage is too long for a quotation, but concludes thus:

O Lord! my boy, my Arthur, my fair son,
My life, my joy, my food, my all the world,
My widow-comfort, and my sorrow's cure. *King John.*

—Similar to this, and equally expressive of conjugal love, is that beautiful hyperbole in Homer; where Andromache, to dissuade her husband from going out to the battle, tells him that she had now no mother, father, or brethren, all her kindred being dead, and her native country desolate; and then tenderly adds,

But while my Hector yet survives, I see
My father, mother, brethren, all in thee. *Iliad*, b. 6.

As the passions that agitate the soul, and rouse the fancy, are apt to vent themselves in tropes and figures, so those that depress the mind adopt for the most part a plain diction without any ornament: for to a dejected mind, wherein the imagination is generally inactive, it is not probable that any great variety of ideas will present themselves; and when these are few and familiar, the words that express them must be simple. As no author equals Shakespeare in boldness or variety of

figures when he copies the style of those violent passions that stimulate the fancy; so, when he would exhibit the human mind in a dejected state, no uninspired writer excels him in simplicity. The same Lear whose resentment had impaired his understanding, while it broke out in the most boisterous language, when, after some medical applications, he recovers his reason, his rage being now exhausted, his pride humbled, and his spirits totally depressed, speaks in a style than which nothing can be imagined more simple or more affecting.

Pray, do not mock me:

I am a very foolish, fond old man,
Fourscore and upward; and, to deal plainly with you,
I fear I am not in my perfect mind.
Methinks I should know you, and know this man;
Yet I am doubtful: for I am mainly ignorant
What place this is; and all the skill I have
Remembers not these garments: nor I know not
Where I did lodge last night. — *Lear*, act 4. sc. 7.

—Desdemona, ever gentle, artless, and sincere, shocked at the unkindness of her husband, and overcome with melancholy, speaks in a style so beautifully simple, and so perfectly natural, that one knows not what to say in commendation of it:

My mother had a maid call'd Barbara;
She was in love, and he she lov'd prov'd mad,
And did forsake her. She had a song of willow;
An old thing it was, but it express'd her fortune,
And she died singing it. That song to-night
Will not go from my mind: I have much to do,
But to go hang my head all at one side,
And sing it like poor Barbara. *Othello*, act 4. sc. 3.

Sometimes the imagination, even when exerted to the utmost, takes in but few ideas. This happens when the attention is totally engrossed by some very great object; admiration being one of those emotions that rather suspend the exercise of the faculties than push them into action. And here, too, the simplest language is the most natural; as when Milton says of the Deity, that he sits "high-throned above all height." And as of this simplicity is more suitable to that one great exertion which occupies the speaker's mind than a more elaborate imagery or language would have been, so has it also a more powerful effect in fixing and elevating the imagination of the hearer; for to introduce other thoughts for the sake of illustrating what cannot be illustrated, could answer no other purpose than to draw off the attention from the principle idea. In these and the like cases, the fancy left to itself will have more satisfaction in pursuing at leisure its own speculations than in attending to those of others; as they who see for the first time some admirable object would choose rather to feast upon it in silence, than to have their thoughts interrupted by a long description from another person, informing them of nothing but what they see before them, are already acquainted with, or may easily conceive.

It was remarked above, that the *hyperbole*, *prosopeia*, and *apostrophe*, are among the most passionate figures. This deserves illustration.

1st, A very angry man is apt to think the injury he has just received greater than it really is; and if he proceed immediately to retaliate by word or deed, seldom fails to exceed the due bounds, and to become injurious in &c.

59
The simplest language most suitable to depressing passions.

Of Tropes
and Fi-
gures.

6
And to the
fanciful
admira-
tion.

61
Hyperbol
natural to
the passion
of anger
love, &c.

Part I.

Of Tropes
and Fi-
gures.

in his turn. The fond parent looks upon his child as a prodigy of genius and beauty; and the romantic lover will not be persuaded that his mistress has nothing supernatural either in her mind or person. Fear, in like manner, not only magnifies its object when real, but even forms an object out of nothing, and mistakes the fictions of fancy for the intimations of sense.—No wonder, then, that they who speak according to the impulse of passion should speak *hyperbolically*; that the angry man should exaggerate the injury he has received, and the vengeance he is going to inflict; that the sorrowful should magnify what they have lost, and the joyful what they have obtained; that the lover should speak extravagantly of the beauty of his mistress, the coward of the dangers he has encountered, and the credulous clown of the miracles performed by the juggler. In fact, these people would not do justice to what they feel if they did not say more than the truth. The valiant man, on the other hand, as naturally adopts the diminishing hyperbole when he speaks of danger; and the man of sense, when he is obliged to mention his own virtue or ability; because it appears to him, or he is willing to consider it, as less than the truth, or at best as inconsiderable. Contempt uses the same figure; and therefore Petruchio, affecting that passion, affects also the language of it:

Thou liest, thou thread, thou thimble,
Thou yard, three-quarters, half-yard, quarter, nail,
Thou flea, thou nit, thou winter-cricket, thou!
Brav'd in mine own house with a skein of thread!
Away, thou rag, thou quantity, thou remnant!

Taming of the Shrew, act 4. sc. 1.

For some passions consider their objects as important, and others as unimportant. Of the former sort are anger, love, fear, admiration, joy, sorrow, pride; of the latter are contempt and courage. Those may be said to subdue the mind to the object, and these to subdue the object to the mind. And the former, when violent, always magnify their objects; whence the hyperbole called *amplification*, or *auxesis*: and the latter as constantly diminish theirs; and give rise to the hyperbole called *meiosis*, or diminution.—Even when the mind cannot be said to be under the influence of any violent passion, we naturally employ the same figure when we would impress another very strongly with any idea. “He is a walking shadow; he is worn to skin and bone; he has one foot in the grave and the other following:”—these, and the like phrases, are proved to be natural by their frequency. By introducing great ideas, the hyperbole is further useful in poetry as a source of the sublime; but when employed injudiciously is very apt to become ridiculous. Cowley makes Goliath as big as the hill down which he was marching†; and tells us, that when he came into the valley he seemed to fill it, and to overtop the neighbouring mountains (which, by the by, seems rather to lessen the mountains and valleys than to magnify the giant); nay, he adds, that the sun started back when he saw the splendour of his arms. This poet seems to have thought that the figure in question could never be sufficiently enormous; but Quintilian would have taught him, “*Quamvis omnis hyperbole ultra fidem, non tamen esse debet ultra modum.*”

The reason is, that this figure, when excessive, betokens rather absolute infatuation than intense emotion; and

resembles the efforts of a ranting tragedian, or the ravings of an enthusiastic declaimer, who, by putting on the gestures and looks of a lunatic, satisfy the discerning part of their audience, that, instead of feeling strongly, they have no rational feelings at all. In the wildest energies of nature there is a modesty which the imitative artist will be careful never to overstep.

2dly, That figure, by which things are spoken of as if they were persons, is called *prosopopæia*, or *personification*. It is a bold figure, and yet is often natural.

Long acquaintance recommends to some share in our affection even things inanimate, as a house, a tree, a rock, a mountain, a country; and were we to leave such a thing, without hope of return, we should be inclined to address it with a farewell, as if it were a perceptive creature. Hence it was that Mary queen of Scotland, when on her return to her own kingdom, so affectionately bade adieu to the country which she had left. “Farewel, France,” said she; “farewel, beloved country, which I shall never more behold!” Nay, we find that ignorant nations have actually worshipped such things, or considered them as the haunt of certain powerful beings. Dryads and hamadryads were by the Greeks and Romans supposed to preside over trees and groves; river gods and nymphs, over streams and fountains; little deities, called *Lares* and *Penates*, were believed to be the guardians of hearths and houses. In Scotland there is hardly a hill remarkable for the beauty of its shape, that was not in former times thought to be the habitation of fairies. Nay, modern as well as ancient superstition has appropriated the waters to a peculiar sort of demon or goblin, and peopled the very regions of death, the tombs and charnel-houses, with multitudes of ghosts and phantoms.—Besides, when things inanimate make a strong impression upon us, whether agreeable or otherwise, we are apt to address them in terms of affection or dislike. The sailor blesses the plank that brought him ashore from the shipwreck; and the passionate man, and sometimes even the philosopher, will say bitter words to the stumbling-block that gave him a fall.—Moreover, a man agitated with any interesting passion, especially of long continuance, is apt to fancy that all nature sympathises with him. If he has lost a beloved friend, he thinks the sun less bright than at other times; and in the sighing of the winds and groves, in the lowings of the herd, and in the murmurs of the stream, he seems to hear the voice of lamentation. But when joy or hope predominate, the whole world assumes a gay appearance. In the contemplation of every part of nature, of every condition of mankind, of every form of human society, the benevolent and the pious man, the morose and the cheerful, the miser and the misanthrope, finds occasion to indulge his favourite passion, and sees, or thinks he sees, his own temper reflected back in the actions, sympathies, and tendencies of other things and persons. Our affections are indeed the medium through which we may be said to survey ourselves, and every thing else; and whatever be our inward frame, we are apt to perceive a wonderful congeniality in the world without us. And hence the fancy, when roused by real emotions, or by the pathos of composition, is easily reconciled to those figures of speech that ascribe sympathy, perception, and the other attributes of animal life, to things inanimate, or even to notions merely intellectual.—Motion, too, bears a close

62

Of Tropes
and Fi-
gures.

Proso-
pæia when
proper.

† *Davidis*,
b. 3.

Of Tropes
and Fi-
gures.

affinity to action, and affects our imagination nearly in the same manner; and we see a great part of nature in motion, and by its sensible effects are led to contemplate energies innumerable. These conduct the rational mind to the Great First Cause; and these, in times of ignorance, disposed the vulgar to believe in a variety of subordinate agents employed in producing those appearances that could not otherwise be accounted for. Hence an endless train of fabulous deities, and of witches, demons, fairies, genii; which, if they prove our reason weak and our fancy strong, prove also that personification is natural to the human mind; and that a right use of this figure may have a powerful effect, in fabulous writing especially, to engage our sympathy in behalf of things as well as persons: for nothing can give lasting delight to a moral being, but that which awakens sympathy, and touches the heart; and though it be true that we sympathise in some degree even with inanimate things, yet what has, or is supposed to have, life, calls forth a more sincere and more permanent fellow-feeling. —Let it be observed further, that to awaken our sympathetic feelings, a lively conception of their object is necessary. This indeed is true of almost all our emotions; their keenness is in proportion to the vivacity of the perceptions that excite them. Distress that we see is more affecting than what we only hear of*; a perusal of the gayest scenes in a comedy does not rouse the mind so effectually as the presence of a cheerful companion; and the death of a friend is of greater energy in producing seriousness, and the consideration of our latter end, than all the pathos of Young. Of descriptions addressed to the fancy, those that are most vivid and picturesque will generally be found to have the most powerful influence over our affections; and those that exhibit persons engaged in action, and adorned with visible insignia, give a brisker impulse to the faculties than such as convey intellectual ideas only, or images taken from still life. No abstract notion of time, or of love, can be so striking to the fancy as the image of an old man accoutred with a scythe, or of a beautiful boy with wings and a bow and arrows: and no physiological account of frenzy could suggest so vivid an idea as the poet has given us in that exquisite portrait,

And moody madness laughing wild amid severest wo.

And for this reason partly it is that the epic poet, in order to work the more effectually upon our passions and imagination, refers the secret springs of human conduct, and the vicissitudes of human affairs, to the agency of personified causes; that is, to the machinery of gods and goddesses, angels, demons, magicians, and other powerful beings. And hence, in all sublime poetry, life and motion, with their several modes and attributes, are liberally bestowed on those objects where-with the author intends that we should be strongly impressed: scenes perfectly inanimate and still, tending rather to diffuse a languor over the mind than to communicate to our internal powers those lively energies without which a being essentially active can never receive complete gratification. —Lastly, some violent passions are peculiarly inclined to change things into persons. The horrors of his mind haunted Orestes in the shape of furies. Conscience, in the form of the murdered person, stares the murderer in the face, and often terrifies him to distraction. The superstitious man,

travelling alone in the dark, mistakes a white stone for a ghost, a bush for a demon, a tree waving with the wind for an enormous giant brandishing a hundred arms. The lunatic and enthusiast converse with persons who exist only in their own disordered fancy; and the glutton and the miser, if they were to give utterance to all their thoughts, would often, it is presumable, speak, the one of his gold, the other of his belly, not only as a person, but as a god,—the object of his warmest love and most devout regard.—More need not be said to prove that personification is natural, and may frequently contribute to the pathos, energy, and beauty of poetic language.

3dly, *Apostrophe*, or a sudden diversion of speech from one person to another person or thing, is a figure nearly related to the former. Poets sometimes make use of it, in order to help out their verse, or merely to give variety to their style: but on these occasions it is to be considered as rather a trick of art, than an effort of nature. It is most natural, and most pathetic, when the person or thing to whom the apostrophe is made, and for whose sake we give a new direction to our speech, is in our eyes eminently distinguished for good or evil, or raises within us some sudden and powerful emotion; such as the hearer would acquiesce in, or at least acknowledge to be reasonable. But this, like the other pathetic figures, must be used with great prudence. For if, instead of calling forth the hearer's sympathy, it should only betray the levity of the speaker, or such wanderings of his mind as neither the subject nor the occasion would lead one to expect, it will then create disgust instead of approbation. The orator, therefore, must not attempt the passionate apostrophe, till the minds of the hearers be prepared to join in it. And every audience is not equally obsequious in this respect. In the forum of ancient Rome that would have passed for sublime and pathetic, which in the most respectable British auditories would appear ridiculous. For our style of public speaking is cool and argumentative; and partakes less of enthusiasm than the Roman did, and much less than the modern French or Italian. Of British eloquence, particularly that of the pulpit, the chief recommendations are gravity and simplicity. And it is vain to say, that our oratory *ought* to be more vehement: for that matter depends on causes, which it is not only inexpedient, but impossible to alter; namely, on the character and spirit of the people, and their rational notions in regard to religion, policy, and literature. The exclamations of Cicero would weigh but little in our parliament; and many of those which we meet with in French sermons would not be more effectual if attempted in our pulpit. To see one of our preachers, who the moment before was a cool reasoner, a temperate speaker, an humble Christian, and an orthodox divine, break out into a sudden apostrophe to the immortal powers, or to the walls of the church, tends to force a smile, rather than a tear, from those among us who reflect, that there is nothing in the subject, and should be nothing in the orator, to warrant such wanderings of fancy or vehemence of emotion. If he be careful to cultivate a pure style, and a grave and graceful utterance, a British clergyman, who speaks from conviction the plain unaffected words of truth and soberness, of benevolence and piety, will, it is believed, convey more pathetic, as well as more permanent, impressions to the heart,

63
Apostrophe
how to be
used.

* Hor. Ar.
Poet. v. 180.

heart, and be more useful as a Christian teacher, than if he were to put in practice all the attitudes of Roscius, and all the tropes and figures of Cicero.

But where the language of passion and enthusiasm is permitted to display itself, whatever raises any strong emotion, whether it be animated or inanimate, absent or present, sensible or intellectual, may give rise to the apostrophe. A man in a distant country, speaking of the place of his birth, might naturally exclaim; "O my dear native land, shall I never see thee more!" Or, when some great misfortune befalls him, "Happy are ye, O my parents, that ye are not alive to see this." We have a beautiful apostrophe in the third book of the *Æneid*, where *Æneas*, who is telling his story to *Dido*, happening to mention the death of his father, makes a sudden address to him as follows:

— hic, pelagi tot tempestatibus actus,
Heu, genitorem, omnis curæ casusque levamen,
Amitto Anchisen: — hic me, pater optime, fessum
Deferis, heu, tantis nequicquam erepte periclis!

This apostrophe has a pleasing effect. It seems to intimate, that the love which the hero bore his father was so great, that when he mentioned him he forgot every thing else; and, without minding his company, one of whom was a queen, suddenly addressed himself to that which, though present only in idea, was still a principal object of his affection. An emotion so warm and so reasonable cannot fail to command the sympathy of the reader. — When Michael, in the eleventh book of *Paradise Lost*, announces to Adam and Eve the necessity of their immediate departure from the garden of Eden, the poet's art in preserving the decorum of the two characters is very remarkable. Pierced to the heart at the thought of leaving that happy place, Eve, in all the violence of ungovernable sorrow, breaks forth into a pathetic apostrophe to Paradise, to the flowers she had reared, and to the nuptial bower she had adorned. Adam makes no address to the walks, the trees, or the flowers of the garden, the loss whereof did not so much afflict him; but, in his reply to the Archangel, expresses, without a figure, his regret for being banished from a place where he had been so oft honoured with a sensible manifestation of the divine presence. The use of the apostrophe in the one case, and the omission of it in the other, not only gives a beautiful variety to the style, but also marks that superior elevation and composure of mind, by which the poet had all along distinguished the character of Adam. — One of the finest applications of this figure that is anywhere to be seen, is in the fourth book of the same poem; where the author, catching by sympathy the devotion of our first parents, suddenly drops his narrative, and joins his voice to theirs in addressing the Father of the universe.

Thus at their shady lodge arriv'd, both stood,
Both turn'd, and under open sky ador'd
The God that made both sky, air, earth, and heav'n,
Which they beheld, the moon's resplendent globe,
And starry pole: — Thou also mad'st the night,
Maker omnipotent! and thou the day,
Which we in our appointed work employ'd
Have finish'd. —

Milton took the hint of this fine contrivance from a well-known passage of Virgil:

Hic juvenum chorus, ille senum; qui carmine laudes
Herculeas et facta ferant; —

— ut duros mille labores

Rege sub Eurytheo, fatis Junonis iniquæ,
Pertulerit: — Tu nubigenas, invictæ, bimembres,
Hylæum Pholoumque, manu; tu Cresia mactas
Prodigia. —

The beauty arising from diversified composition is the same in both, and very great in each. But every reader must feel, that the figure is incomparably more affecting to the mind in the imitation than in the original. So true it is, that the most rational emotions raise the most intense fellow-feeling; and that the apostrophe is then the most emphatical, when it displays those workings of human affection which are at once ardent and well-founded.

To conclude this head: Tropes and figures, particularly the *metaphor*, *similitude*, and *allegory*, are further useful in beautifying language, by suggesting, together with the thoughts essential to the subject, an endless variety of agreeable images, for which there would be no other place, if writers were always to confine themselves to the proper names of things. And this beauty and variety, judiciously applied, is so far from distracting, that it tends rather to fix, the attention, and captivate the heart of the readers, by giving light, and life, and pathos, to the whole composition.

II. That tropes and figures are more necessary to poetry, than to any other mode of writing, was the second point proposed to be illustrated in this section.

Language, as already observed, is then natural, when it is suitable to the supposed condition of the speaker. Figurative language is peculiarly suitable to the supposed condition of the poet; because figures are suggested by the fancy; and the fancy of him who composes poetry is more employed than that of any other author. Of all historical, philosophical, and theological researches, the object is *real* truth, which is fixed and permanent. The aim of rhetorical declamation (according to Cicero) is *apparent* truth; which, being less determinate, leaves the fancy of the speaker more free, gives greater scope to the inventive powers, and supplies the materials of a more figurative phraseology. But the poet is subject to no restraints, but those of verisimilitude; which is still less determinate than rhetorical truth. He seeks not to convince the judgment of his reader by arguments of either real or apparent cogency; he means only to please and interest him, by an appeal to his sensibility and imagination. His own imagination is therefore continually at work, ranging through the whole of real and probable existence, "glancing from heaven to earth, from earth to heaven," in quest of images and ideas suited to the emotions he himself feels, and to the sympathies he would communicate to others. And, consequently, figures of speech, the offspring of excursive fancy, must (if he speak according to what he is supposed to think and feel, that is, according to his supposed condition) tincture the language of the poet more than that of any other composer. So that, if figurative diction be unnatural in geometry, because all wanderings of fancy are unsuitable, and even impossible, to the geometrician, while intent upon his argument; it is, upon the same principle, perfectly

Of Tropes
and Fi-
gures

feetly natural, and even unavoidable, in poetry; because the more a poet attends to his subject, and the better qualified he is to do it justice, the more active will his imagination be, and the more diversified the ideas that present themselves to his mind. — Besides, the true poet addresses himself to the passions and sympathies of mankind; which, till his own be raised, he cannot hope to do with success. And it is the nature of many passions, though not of all, to increase the activity of imagination: and an active imagination naturally vents itself in figurative language; nay, unless restrained by a correct taste, has a tendency to exceed in it; of which Bishop Taylor and Lord Verulam, two geniuses different in kind, but of the highest order, are memorable examples.

We said, that “the poet seeks not to convince the judgment of his reader by arguments of either real or apparent cogency.” — We do not mean, that in poetry argument has no place. The most legitimate reasoning, the soundest philosophy, and narratives purely historical, may appear in a poem, and contribute greatly to the honour of the author, and to the importance of his work. All this we have in *Paradise Lost*. — We mean, that what distinguishes *pure* poetry from other writing, is its aptitude, not to sway the judgment by reasoning, but to please the fancy, and move the passions, by a lively imitation of nature. Nor would we exclude poetical embellishment from history, or even from philosophy. Plato’s *Dialogues* and the *Moral Essays* of Addison and Johnson abound in poetic imagery; and Livy and Tacitus often amuse their readers with poetical description. In like manner, though geometry and physics be different sciences; though abstract ideas be the subject, and pure demonstration or intuition the evidence, of the former; and though the material universe, and the informations of sense, be the subject and the evidence of the latter; yet have these sciences been united by the best philosophers, and very happy effects resulted from the union. — In one and the same work, poetry, history, philosophy, and oratory, may doubtless be blended; nay, these arts have all been actually blended in one and the same work, not by Milton only, but also by Homer, Virgil, Lucan, and Shakespeare. Yet still these arts are different; different in their ends and principles, and in the faculties of the mind to which they are respectively addressed: and it is easy to perceive when a writer employs one and when another.

§ 2. Of the Sound of Poetical Language.

As the ear, like every other perceptive faculty, is capable of gratification, regard is to be had to the sound of words, even in prose. But to the harmony of language, it behoves the poet, more than any other writer, to attend; as it is more especially his concern to render his work pleasurable. In fact, we find, that no poet was ever popular who did not possess the art of harmonious composition.

What belongs to the subject of Poetical Harmony

4

may be referred to one or other of these heads, *Sweetness*, *Measure*, and *Imitation*.

I. In order to give *sweetness* to language, either in verse or prose, all words of harsh sound, difficult pronunciation, or unwieldy magnitude, are to be avoided as much as possible, unless when they have in the sound something peculiarly emphatical; and words are to be so placed in respect of one another, as that discordant combinations may not result from their union. But in poetry this is more necessary than in prose; poetical language being understood to be an imitation of natural language improved to that perfection which is consistent with probability. To poetry, therefore, a greater latitude must be allowed than to prose, in expressing, by tropes and figures of pleasing sound, those ideas whereof the proper names are in any respect offensive, either to the ear or to the fancy.

II. How far versification or *regular measure* may be essential to this art, has been disputed by critical writers; some holding it to be indispensably necessary, and some not necessary at all.

The fact seems to be, as already hinted, that to poetry verse is not essential. In a prose work, we may have the fable, the arrangement, and a great deal of the pathos and language, of poetry; and such a work is certainly a poem, though perhaps not a perfect one. For how absurd would it be to say, that by changing the position only of a word or two in each line, one might divest Homer’s *Iliad* of the poetical character! At this rate, the arts of poetry and versification would be the same; and the rules in Despauter’s *Grammar*, and the moral distichs ascribed to Cato, would be as real poetry as any part of Virgil. In fact, some very ancient poems, when translated into a modern tongue, are far less poetical in verse than in prose; the alterations necessary to adapt them to our numbers being detrimental to their sublime simplicity; of which any person of taste will be sensible, who compares our common prose-version of Job, the *Psalms*, and the *Song of Solomon*, with the best metrical paraphrase of those books that has yet appeared. Nay, in many cases, Comedy will be more poetical, because more pleasing and natural, in prose than in verse. By versifying Tom Jones, and *The Merry Wives of Windsor*, we should spoil the two finest comic poems, the one epic, the other dramatical, now in the world.

But, secondly, though verse be not essential to poetry, it is necessary to the perfection of all poetry that admits of it. Verse is to poetry, what colours are to painting (c). A painter might display great genius, and draw masterly figures with chalk or ink; but if he intend a perfect picture, he must employ in his work as many colours as are seen in the object he imitates. Or, to adopt a beautiful comparison of Demosthenes, quoted by Aristotle*, “Versification is to poetry what bloom is to the human countenance.” A good face is agreeable when the bloom is gone, and good poetry may please without versification; harmonious numbers may

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(c) Horace seems to hint at the same comparison, when, after specifying the several sorts of verse suitable to Epic, Elegiac, Lyric, and Dramatic Poetry, he adds,

Descriptas servare vices, operumque colores.

Cur ego, si nequeo ignoroque, Poeta salutor?

Ar. Poet. ver. 86.

66
The poet
ought to
attend to
the har-
mony of
language,
which con-
sists in

69
Adds to
the perfec-
tion of
poetry.

* *Rhetori-*
lib. 3.

cap. 4.

Of Poetical Harmony
 set off an indifferent poem, and a fine bloom indifferent features : but, without verse, poetry is incomplete ; and beauty is not perfect, unless to sweetness and regularity of feature there be superadded,

The bloom of young desire, and purple light of love.

If numbers are necessary to the perfection of the higher poetry, they are no less so to that of the lower kinds, to Pastoral, Song, and Satire, which have little besides the language and versification to distinguish them from prose ; and which some ancient authors are unwilling to admit to the rank of poems : though it seems too nice a scruple, both because such writings are commonly termed *poetical* ; and also because there is, even in them, something that may not improperly be considered as an imitation of nature.

That the rhythm and measures of verse are naturally agreeable, and therefore that by these poetry may be made more pleasing than it would be without them, is evident from this, that children and illiterate people, whose admiration we cannot suppose to be the effect of habit or prejudice, are exceedingly delighted with them. In many proverbial sayings, where there is neither rhyme nor alliteration, rhythm is obviously studied. Nay, the use of rhythm in poetry is universal ; whereas alliteration and rhyme, though relished by some nations, are not much sought after by others. And we need not be at a loss to account for the agreeableness of proportion and order, if we reflect, that they suggest the agreeable ideas of contrivance and skill, at the same time that they render the connection of things obvious to the understanding, and imprint it deeply on the memory. Verse, by promoting distinct and easy remembrance, conveys ideas to the mind with energy, and enlivens every emotion the poet intends to raise in the reader or hearer. Besides, when we attend to verses, after hearing one or two, we become acquainted with the measure, which therefore we always look for in the sequel. This perpetual interchange of hope and gratification is a source of delight ; and to this in part is owing the pleasure we take in the rhymes of modern poetry. And hence we see, that though an incorrect rhyme or untuneable verse be in itself, and compared with an important sentiment, a very trifling matter ; yet it is no trifle in regard to its effects on the hearer ; because it brings disappointment, and so gives a temporary shock to the mind, and interrupts the current of the affections ; and because it suggests the disagreeable ideas of negligence or want of skill on the part of the author. And therefore, as the public ear becomes more delicate, the negligence will be more glaring, and the disappointment more intensely felt ; and correctness of rhyme and of measure will of course be the more indispensable. In our tongue, rhyme is more necessary to Lyric than to Heroic poetry. The reason seems to be, that in the latter the ear can of itself perceive the boundary of the measure, because the lines are all of equal length nearly, and every good reader makes a short pause at the end of each ; whereas, in the former, the lines vary in length : and therefore the rhyme is requisite to make the measure and rhythm sufficiently perceptible. Custom too may have some influence. English Odes without rhyme are uncommon ; and therefore have something awkward about them, or something at least to which the public ear is not yet thoroughly reconciled. Indeed, when the drama is excepted, we do

not think that rhyme can be safely spared from English poetry of any kind, but when the subject is able to support itself. " He that thinks himself capable of astonishing (says Johnson) may write blank verse ; but those that hope only to please, must condescend to rhyme."

Rhyme, however, is of less importance by far than rhythm, which in poetry as well as in music is the source of much pleasing variety ; of variety tempered with uniformity, and regulated by art ; inasmuch that, notwithstanding the likeness of one hexameter verse to another, it is not common, either in Virgil or in Homer, to meet with two contiguous hexameters whose rhythm is exactly the same. And though all English heroic verses consist of five feet, among which the iambic predominates ; yet this measure, in respect of rhythm alone, is susceptible of more than 30 varieties. And let it be remarked further, that different kinds of verse, by being adapted to different subjects and modes of writing, give variety to the poetic language, and multiply the charms of this pleasing art.

What has formerly been shown to be true in regard to style, will also in many cases hold true of versification, " that it is then *natural*, when it is adapted to the supposed condition of the speaker."—In the epopee, the poet assumes the character of calm inspiration ; and therefore his language must be elevated, and his numbers majestic and uniform. A peasant speaking in heroic or hexameter verse is no improbability here ; because his words are supposed to be transmitted by one who will of his own accord give them every ornament necessary to reduce them into dignified measure ; as an eloquent man, in a solemn assembly, recapitulating the speech of a clown, would naturally express it in pure and perspicuous language. The uniform heroic measure will suit any subject of dignity, whether narrative or didactic, that admits or requires uniformity of style. In tragedy, where the imitation of real life is more perfect than in epic poetry, the uniform magnificence of epic numbers might be improper ; because the heroes and heroines are supposed to speak in their own persons, and according to the immediate impulse of passion and sentiment. Yet, even in tragedy, the versification may be both harmonious and dignified ; because the characters are taken chiefly from high life, and the events from a remote period ; and because the higher poetry is permitted to imitate nature, not as it is, but in that state of perfection in which it might be. The Greeks and Romans considered their hexameter as too artificial for dramatic poetry ; and therefore in tragedy, and even in comedy, made use of the iambic, and some other measures that came near the cadence of conversation : we use the iambic both in the epic and dramatic poem ; but for the most part it is, or ought to be, much more elaborate in the former than in the latter. In dramatic comedy, where the manners and concerns of familiar life are exhibited, verse would seem to be unnatural, except it be so like the sound of common discourse as to be hardly distinguishable from it. Custom, however, may in some countries determine otherwise ; and against custom, in these matters, it is vain to argue. The professed enthusiasm of the dithyrambic poet renders wildness, variety, and a sonorous harmony of numbers, peculiarly suitable to his odes. The love-sonnet, and Anacreontic song, will be less various, more regular,

70
 In what cases rhyme may be dispensed with in English poetry.

71
 The language of the epic poet must be elevated and his numbers uniformly majestic.

72
 In tragedy the same uniform magnificence would be improper, and much more so in comedy.

Of Poetical
Harmony.

lar, and of a softer harmony; because the state of mind expressed in it has more composure. Philosophy can scarce go further in this investigation, without deviating into whim and hypothesis. The particular sorts of verse to be adopted in the lower species of poetry, are determined by fashion chiefly, and the practice of approved authors.

III. The origin and principles of *imitative harmony*, or of that artifice by which the sound is made, as Pope says, "an echo to the sense," may be explained in the following manner.

73
A striking
analogy be-
tween mor-
al and ma-
terial beau-
ty and de-
formity.

It is pleasing to observe the uniformity of nature in all her operations. Between moral and material beauty and harmony, between moral and material deformity and dissonance, there obtains a very striking analogy. The visible and audible expressions of almost every virtuous emotion are agreeable to the eye and the ear, and those of almost every criminal passion disagreeable. The looks, the attitudes, and the vocal sounds, natural to benevolence, to gratitude, to compassion, to piety, are in themselves graceful and pleasing; while anger, discontent, despair, and cruelty, bring discord to the voice, deformity to the features, and distortion to the limbs. That flowing curve, which painters know to be essential to the beauty of animal shape, gives place to a multiplicity of right lines and sharp angles in the countenance and gesture of him who knits his brows, stretches his nostrils, grinds his teeth, and clenches his fist; whereas, devotion, magnanimity, benevolence, contentment, and good-humour, soften the attitude, and give a more graceful swell to the outline of every feature. Certain vocal tones accompany certain mental emotions. The voice of sorrow is feeble and broken, that of despair boisterous and incoherent; joy assumes a sweet and sprightly note, fear a weak and tremulous cadence; the tones of love and benevolence are musical and uniform, those of rage loud and dissonant; the voice of the sedate reasoner is equable and grave, but not unpleasant; and he who declaims with energy, employs many varieties of modulation suited to the various emotions that predominate in his discourse.

But it is not in the language of passion only that the human voice varies its tone, or the human face its features. Every striking sentiment, and every interesting idea, has an effect upon it. One would esteem that person no adept in narrative eloquence, who should describe, with the very same accent, swift and slow motion, extreme labour and easy performance, agreeable sensation and excruciating pain; who should talk of the tumult of a tempestuous ocean, the roar of thunder, the devastations of an earthquake, or an Egyptian pyramid tumbling into ruins, in the same tone of voice where-with he describes the murmur of a rill, the warbling of

the harp of Æolus, the swinging of a cradle, or the descent of an angel. Elevation of mind gives dignity to the voice. From Achilles, Sarpedon, and Othello, we should as naturally expect a manly and sonorous accent, as a nervous style and majestic attitude. Coxcombs and bullies, while they assume airs of importance and valour, affect also a dignified articulation.

Since the tones of natural language are so various, poetry, which imitates the language of nature, must also vary its tones; and, in respect of sound as well as of meaning, be framed after that model of ideal perfection, which the variety and energy of the human articulate voice render probable. This is the more easily accomplished, because in every language there is between the sound and sense of certain words a perceptible analogy; which, though not so accurate as to lead a foreigner from the sound to the signification, is yet accurate enough to show, that, in forming such words, regard has been had to the imitative qualities of vocal sound. Such, in English, are the words *yell, crash, hiss, roar, murmur*, and many others.

All the particular laws that regulate this sort of imitation, as far as they are founded in nature, and liable to the cognizance of philosophy, depend on the general law of style above mentioned. Together with the other circumstances of the supposed speaker, the poet takes into consideration the tone of voice suitable to the ideas that occupy his mind, and thereto adapts the sound of his language, if it can be done consistently with ease and elegance of expression. But when this imitative harmony is too much sought after, or words appear to be chosen for sound rather than sense, the verse becomes finical and ridiculous. Such is Ronsard's affected imitation of the song of the sky-lark:

Elle quindée du zéphire
Sublime en l'air vire et revire,
Et y declique un joli cris,
Qui rit, guérit, et tire l'ire
Des esprit mieux que je n'écris.

This is as ridiculous as that line of Ennius.

Tum tuba terribili sonitu taratantara dixit:

Or as the following verses of Swift;

The man with the kettle-drum enters the gate,
Dub dub a dub dub: the trumpeters follow,
Tantara tantara; while all the boys hollow.

Words by their sound may imitate sound; and quick or slow articulation may imitate quick or slow motion. Hence, by a proper choice and arrangement of words, the poet may imitate *Sounds* that are sweet with dignity (H),—sweet and tender (I),—loud (K),—and

harsh

(H) No sooner had th' Almighty ceas'd, than all
The multitude of angels, with a shout
Loud as from numbers without number, sweet
As from blest voices uttering joy; heav'n rung
With jubilee, and loud hosannas fill'd
Th' eternal regions. — Par. Lost, b. 3.

See also the night-storm of thunder, lightning, wind, and rain, in Virg. Georg. lib. 1. ver. 328—334.

(I) Et longum, formosè, vale, vale, inquit, Iola.

Virg. Ecl. 1.

Formosam resonare doces Amarillida silyas.

Virg. Ecl. 1.

See also the simile of the nightingale, Geor. lib. 4. ver. 511. And see that wonderful couplet describing the wailings of the owl, Æneid IV. 462.

(K) — — — vibratus ab æthere fulgor
Cum sonitu venit, et ruere omnia visa repente,
Tyrrhenusque tubæ mugire per æthera clangor,
Suspiciunt: iterum atque iterum fragor intonat ingens.
Æneid. 8.

See

harsh (L);—and *Motions* that are slow, in consequence of dignity (M);—slow in consequence of difficulty (N), swift and noisy (O)—swift and smooth (P)—uneven and abrupt (Q);—quick and joyous (R). An unexpected pause in the verse may also imitate a sudden failure of strength (S), or interruption of motion (T), or give vivacity to an image or thought, by fixing our attention longer than usual upon the word that precedes it (U).—Moreover, when we describe great bulk, it is natural for us to articulate slowly, even in common discourse; and therefore a line of poetry that requires

a slow pronunciation, or seems longer than it should be, may be used with good effect in describing vastness of size (X).—Sweet and smooth numbers are most proper, when the poet paints agreeable objects, or gentle energy (Y); and harsher sounds when he speaks of what is ugly, violent, or disagreeable (Z). This too is according to the nature of common language; for we generally employ harsher tones of voice to express what we dislike, and more melodious notes to describe the objects of love, complacency, or admiration. Harsh numbers, however, should not be frequent in poetry: for

See also the storm in the first book of the *Æneid*, and in the fifth of the *Odyssey*.

(L) The hoarse rough verse shall like the torrent roar.
Pope.

————— On a sudden open fly,
With impetuous recoil and jarring sound,
Th' infernal doors, and on their hinges grate
Harsh thunder. ————— *Par. Lost*, II. 879.

See also Homer's *Iliad*, lib. 2. ver. 363. and Clarke's Annotation.

(M) See an exquisite example in Gray's Progress of Poetry; the conclusion of the third stanza.

(N) And when 'up ten steep slopes you've dragg'd
your thighs. *Pope.*

Just brought out this, when scarce his tongue could stir. *Pope.*

————— The huge leviathan
Wallowing unwieldy, enormous in their gait,
Tempest the ocean. *Par. Lost*, VII. 411.

See the famous description of Sisyphus rolling the stone, *Odysf.* lib. 11. ver. 592. See Quintil. *Inst. Orat.* lib. 9. cap. 4. § 4. compared with *Paradise Lost*, book 2. ver. 1022.

(O) Quadrupedante putrem sonitu quatit ungula
campum. *Æneid.*

Αὐτὰρ ἐπεὶα πιδόνδε κυλινδῖτο λαὰς ἀναιδής. *Odysf.* 11.

See also Virg. *Æneid.* lib. 1. ver. 83—87.

(P) See wild as the winds o'er the desert he flies.
Pope.

Ille volat, simul arva fuga, simul æquora verrens.
Virg.

Ἡδὴν τ' ἐπεὶα πῖλαι, χαλεπὴ πηρεῖσσα. *Hesiod.*

(Q) Πολλὰ δ' ἀνὰντα κατὰντα παρὰντα τε δοχμῖα τ' ἠλθόν. *Hom.*

The last shriek'd, started up, and shriek'd again.
Anonym.

(R) Let the merry bells ring round,
And the jocund rebecks sound,
To many a youth, and many a maid,
Dancing in the chequer'd shade. *Milt. Allegro.*

See also Gray's Progress of Poetry, stanza 3.

(S) Ac velut in somnis oculis ubi languida preffitt
Nocte quies, nequicquam avidos extendere cursus

Velle videmur:—et in mediis conatibus ægri
Succidimus. ————— *Æneid.*

See also Virg. *Georg.* lib. 3. ver. 515, 516.

(T) For this, be sure to-night thou shalt have cramps,
Side-stitches that shall pen thy breath up. Urchins
Shall exercise upon thee. —————
Prospero to Caliban in *the Tempest*.

See Pope's *Iliad*, XIII. 199.

(U) ——— How often from the steep
Of echoing hill or thicket have we heard
Celestial voices, to the midnight air,
Sole,—or responsive to each other's note,
Singing their great Creator? ————— *Par. Lost*, b. 4.

And over them triumphant Death his dart
Shook, ——— but delay'd to strike. *Id.*

See also Hom. *Odysf.* l. 9. v. 290.

(X) Thus stretch'd out, huge in length, the arch fiend
lay. *Par. Lost.*

Monstrum horrendum, informe, ingens, cui lumen
ademptum. *Æneid.* 3.

Et magnos membrorum artus, magna ossa, lacertosque
Exuit, atque ingens media consistit arena.
Æneid. v. 422.

(Y) Hic gelidi fontes, hic mollia prata, Lycori,
Hic nemus, hic ipso tecum consumerer ævo.
Virg. Ecl. 10.

The dumb shall sing; the lame his crutch forego,
And leap, exulting, like the bounding roe.
Pope's Messiah.

See Milton's description of the evening, *Par. Lost*, book 4. ver. 598—609.

Ye gentle gales beneath my body blow,
And softly lay me on the waves below.
Pope's Sappho.

(Z) Stridenti stipula miserum disperdere carmen.
Virg. Ecl. 3.

Immo ego Sardois videar tibi amarior herbis,
Horridior rusco, projecta vilior alga.
Virg. Ecl. 7.

Neu patriæ validas in viscera vertite vires.
Virg. Æneid. 6.

See also Milton's description of the Lazar-house in *Paradise Lost*, b. 11. v. 477—492.

Of the
Epoëe and
Drama.

for in this art, as in music, concord and melody ought always to predominate. And we find in fact, that good poets can occasionally express themselves somewhat harshly, when the subject requires it, and yet preserve the sweetness and majesty of poetical diction. Further, the voice of complaint, pity, love, and all the gentler affections, is mild and musical, and should therefore be imitated in musical numbers; while despair, defiance, revenge, and turbulent emotions in general, assume an abrupt and sonorous cadence. Dignity of description (A), solemn vows (B), and all sentiments that proceed from a mind elevated with great ideas (C), require a correspondent pomp of language and versification.—Lastly, an irregular or uncommon movement in the verse may sometimes be of use, to make the reader conceive an image in a particular manner. Virgil, describing horses running over rocky heights at full speed,

begins the line with two dactyls, to imitate rapidity, and concludes it with eight long syllables:

Saxa per, et scopulos, et depressas convalles.

Geor. III. 276.

which is a very unusual measure, but seems well adapted to the thing expressed, namely, to the descent of the animal from the hills to the low ground. At any rate, this extraordinary change of the rhythm may be allowed to bear some resemblance to the animal's change of motion, as it would be felt by a rider, and as we may suppose it is felt by the animal itself.

Other forms of imitative harmony, and many other examples, besides those referred to in the margin, will readily occur to all who are conversant in the writings of the best versifiers, particularly Homer, Virgil, Milton, Lucretius, Spenser, Dryden, Shakespeare, Pope, and Gray.

Of the
Epoëe and
Drama.

PART II. OF THE DIFFERENT SPECIES OF POETRY, with their PARTICULAR PRINCIPLES.

SECT. I. Of Epic and Dramatic Compositions.

§ 1. The *Epoëe* and *Drama* compared.

*Elem. of
Criticism.*
76
In what
tragic and
epic poetry
agree, and
in what
they differ.

TRAGEDY and the epic differ not in substantial: in both the same ends are proposed, viz. instruction and amusement; and in both the same mean is employed, viz. imitation of human actions. They differ only in the manner of imitating: epic poetry employs narration; tragedy represents its facts as passing in our sight: in the former, the poet introduces himself as an historian; in the latter, he presents his actors, and never himself.

This difference, regarding form only, may be thought slight: but the effects it occasions are by no means so; for what we see makes a deeper impression than what we learn from others. A narrative poem is a story told by another: facts and incidents passing upon the stage, come under our own observation; and are beside much enlivened by action and gesture, expressive of many sentiments beyond the reach of language.

A dramatic composition has another property, independent altogether of action; which is, that it makes a deeper impression than narration: in the former, persons express their own sentiments; in the latter, sentiments are related at second-hand. For that reason, Aristotle, the father of critics, lays it down as a rule*, That in an epic poem the author ought to take every opportunity of introducing his actors, and of confining the narrative part within the narrowest bounds. Homer understood perfectly the advantage of this method; and his poems are both of them in a great measure dramatic. Lucan runs to the opposite extreme; and is guilty of a still greater fault, in stuffing his *Phar-*

lia with cold and languid reflections, the merit of which he assumes to himself, and deigns not to share with his actors. Nothing can be more injudiciously timed, than a chain of such reflections, which suspend the battle of *Pharfalia* after the leaders had made their speeches, and the two armies are ready to engage†.

Aristotle, from the nature of the fable, divides tragedy into simple and complex: but it is of greater moment, with respect to dramatic as well as epic poetry, to found a distinction upon the different ends attained by such compositions. A poem, whether dramatic or epic, that has nothing in view but to move the passions and to exhibit pictures of virtue and vice, may be distinguished by the name of *pathetic*: but where a story is purposely contrived to illustrate some moral truth, by showing that disorderly passions naturally lead to external misfortunes, such composition may be denominated *moral*. Beside making a deeper impression than can be done by cool reasoning, a moral poem does not fall short of reasoning in affording conviction: the natural connection of vice with misery, and of virtue with happiness, may be illustrated by stating a fact as well as by urging an argument. Let us assume, for example, the following moral truths: That discord among the chiefs renders ineffectual all common measures; and that the consequences of a slightly-founded quarrel, fostered by pride and arrogance, are not less fatal than those of the grossest injury: these truths may be inculcated by the quarrel between Agamemnon and Achilles at the siege of Troy. If facts or circumstances be wanting, such as tend to rouse the turbulent passions, they must be invented; but no accidental nor unaccountable event ought to be admitted; for the necessary or probable connection between vice and misery

† *Lib. 7.*
from line
383 to line
460.
77
Tragic and
epic poetry
pathetic
or moral.

* *Poet. chap.*
25. sect. 6.

(A) See Virg. *Geor.* l. 328. and Homer, Virgil, and Milton, *passim*. See also Dryden's *Alexander's Feast*, and Gray's *Odes*.

(B) See Virg. *Æneid*, IV. 24.

(C) Examples are frequent in the great authors. See Othello's exclamation:

O now for ever
Farewell the tranquil mind! &c.

Act 3. sc. 3.

Of the
Epopée and
Drama.

78
The good
effect of
such com-
positions.

is not learned from any events but what are naturally occasioned by the characters and passions of the persons represented, acting in such circumstances. A real event, of which we see not the cause, may afford a lesson, upon the presumption that what hath happened may again happen: but this cannot be inferred from a story that is known to be a fiction.

Many are the good effects of such compositions. A pathetic composition, whether epic or dramatic, tends to a habit of virtue, by exciting us to do what is right, and restraining us from what is wrong. Its frequent pictures of human woes produce, beside, two effects, extremely salutary: they improve our sympathy, and fortify us to bear our own misfortunes. A moral composition must obviously produce the same good effects, because by being moral it ceaseth not to be pathetic: it enjoys besides an excellence peculiar to itself; for it not only improves the heart, as above-mentioned, but instructs the head by the moral it contains. It seems impossible to imagine any entertainment more suited to a rational being, than a work thus happily illustrating some moral truth; where a number of persons of different characters are engaged in an important action, some retarding, others promoting, the great catastrophe; and where there is dignity of style as well as of matter. A work of this kind has our sympathy at command, and can put in motion the whole train of the social affections: our curiosity in some scenes is excited, in others gratified; and our delight is consummated at the close, upon finding, from the characters and situations exhibited at the commencement, that every incident down to the final catastrophe is natural, and that the whole in conjunction make a regular chain of causes and effects.

Considering that an epic and a dramatic poem are the same in substance, and have the same aim or end, one will readily imagine, that subjects proper for the one must be equally proper for the other. But considering their difference as to form, there will be found reason to correct that conjecture, at least in some degree. Many subjects may indeed be treated with equal advantage in either form: but the subjects are still more numerous for which they are not equally qualified; and there are subjects proper for the one and not at all for the other. To give some slight notion of the difference, as there is no room here for enlarging upon every article, we observe, that dialogue is better qualified for expressing sentiments, and narrative for displaying facts. Heroism, magnanimity, undaunted courage, and other elevated virtues, figure best in action: tender passions, and the whole tribe of sympathetic affections, figure best in sentiment. It clearly follows, that tender passions are more peculiarly the province of tragedy, grand and heroic actions of epic poetry.

* Blair's
Lectures.

"The epic poem is universally allowed to be*, of all poetical works, the most dignified, and, at the same time, the most difficult in execution. To contrive a story which shall please and interest all readers, by being at once entertaining, important, and instructive; to fill it with suitable incidents; to enliven it with a variety of characters and of descriptions; and, throughout a long work, to maintain that propriety of sentiment, and that elevation of style, which the epic character requires, is unquestionably the highest effort of poetical genius.

VOL. XV. Part I.

"The action or subject of the epic poem must be great and interesting. Without greatness it would not have sufficient importance either to fix our attention or to justify the magnificent apparatus which the poet bestows on it. This is so evidently requisite as not to require illustration; and, indeed, hardly any who have attempted epic poetry have failed in choosing some subject sufficiently important, either by the nature of the action or by the fame of the personages concerned in it. The fame of Homer's heroes, and the consequences of dissension between the greatest of them, is a subject important in itself, and must have appeared particularly so to his countrymen, who boasted their descent from those heroes. The subject of the *Æneid* is still greater than that of the *Iliad*, as it is the foundation of the most powerful empire that ever was established upon this globe; an event of much greater importance than the destruction of a city, or the anger of a senibarbarous warrior. But the poems of Homer and Virgil fall in this respect infinitely short of that of Milton. 'Before the greatness displayed in *Paradise Lost*, it has been well observed § that all other greatness shrinks away. The subject of the English poet is not the destruction of a city, the conduct of a colony, or the foundation of an empire: it is the fate of worlds, the revolutions of heaven and earth; rebellion against the Supreme King, raised by the highest order of created beings; the overthrow of their host, and the punishment of their crime; the creation of a new race of reasonable creatures; their original happiness and innocence, their forfeiture of immortality, and their restoration to hope and peace."

Of the
Epopée and
Drama.
80
The proper
subject of
an epic
poem.

An epic poem, however, is defective if its action be not interesting as well as great; for a narrative of mere valour may be so constructed as to prove cold and tiresome. "Much* will depend on the happy choice of some subject, which shall by its nature interest the public; as when the poet selects for his hero one who is the saviour, or the deliverer, or the favourite of his nation; or when he writes achievements that have been highly celebrated, or have been connected with important consequences to any public cause. Most of the great epic poems are abundantly fortunate in this respect, and must have been very interesting to those ages in which they were composed." The subject of the *Paradise Lost*, as it is infinitely greater, must likewise be considered as more universally interesting than that of any other poem. "We all feel the effects of Adam's transgression; we all sin like him, and like him must all bewail our offences. We have restless and insidious enemies in the fallen angels, and in the blessed spirits we have guardians and friends; in the redemption of mankind we hope to be included; in the description of heaven and hell we are surely interested, as we are all to reside hereafter either in the regions of horror or bliss."

"The chief circumstance which renders an epic poem interesting†, and which tends to interest not one age or country alone, but all readers, is the skilful conduct of the author in the management of his subject. His plan must comprehend many affecting incidents. He may sometimes be awful and august; he must often be tender and pathetic; he must give us gentle and pleasing scenes of love, friendship, and affection. The more that an epic poem abounds with situations which

81
Circum-
stances
chiefly in-
teresting in
epic poetry.
† Blair and
Johnson.

C c

awaken

Of the
Epoëe and
Drama.

awaken the feelings of humanity, it is the more interesting. In this respect perhaps no epic poets have been so happy as Virgil and Tasso. The plan of the *Paradise Lost* comprises neither human actions nor human manners. The man and woman who act and suffer, are in a state which no other man or woman can ever know. The reader finds no transaction in which he can be engaged; beholds no condition in which he can by any effort of imagination place himself; he has therefore little natural curiosity or sympathy."

82
Whether
the hero
must neces-
sarily be
successful.

A question has been moved, Whether the nature of the epic poem does not require that the hero should be ultimately successful? To this question Johnson replies, that "there is no reason why the hero should not be unfortunate, except established practice, since success and virtue do not necessarily go together." Most critics, however, are of a different opinion, and hold success to be, if not the necessary, at least the most proper issue of an epic poem. An unhappy conclusion depresses the mind, and is opposite to the elevating emotions which belong to this species of poetry. Terror and compassion are the proper subjects of tragedy; but as the epic is of larger extent, it were too much, if, after the difficulties and troubles which commonly abound in the progress of the poem, the author should bring them all at last to an unfortunate conclusion. We know not that any author of name has held this course except *Lucan*; for in the *Paradise Lost*, as Adam's deceiver is at last crushed, and he himself restored to the favour of his maker, Milton's hero must be considered as finally successful.

83
Different
kinds of
dramatic
poetry.

We have no occasion to say more of the epic, considered as peculiarly adapted to certain subjects, and to be conducted according to a certain plan. But as dramatic subjects are more complex, it is necessary to take a narrower view of them. They are either the light and the gay, or the grave and affecting, incidents of human life. The former constitute the subject of comedy, and the latter of tragedy.

As great and serious objects command more attention than little and ludicrous ones; as the fall of a hero interests the public more than the marriage of a private person; tragedy has been always held a more dignified entertainment than comedy. The first thing required of the tragic poet is, that he pitch upon some moving and interesting story, and that he conduct it in a natural and probable manner. For we must observe, that the natural and probable are more essential to tragic than even to epic poetry. Admiration is excited by the wonderful; but passion can be raised only by the impressions of nature and truth upon the mind.

84
Subjects
best suited
to tragedy.

The subject best fitted for tragedy is where a man has himself been the cause of his misfortune; not so as to be deeply guilty, nor altogether innocent: the misfortune must be occasioned by a fault incident to human nature, and therefore in some degree venial. Such misfortunes call forth the social affections, and warmly interest the spectator. An accidental misfortune, if not extremely singular, doth not greatly move our pity: the person who suffers, being innocent, is freed from the greatest of all torments, that anguish of mind which is occasioned by remorse. An atrocious criminal, on the other hand, who brings misfortunes upon himself, excites little pity, for a different reason: his

remorse, it is true, aggravates his distress, and swells the first emotions of pity; but then our hatred of him as a criminal blending with pity, blunts its edge considerably. Misfortunes that are not innocent, nor highly criminal, partake the advantages of each extreme: they are attended with remorse to embitter the distress, which raises our pity to a great height; and the slight indignation we have at a venial fault detracts not sensibly from our pity. The happiest of all subjects accordingly for raising pity, is where a man of integrity falls into a great misfortune by doing an action that is innocent, but which, by some singular means, is conceived by him to be criminal: his remorse aggravates his distress; and our compassion, unrestrained by indignation, knows no bounds. Pity comes thus to be the ruling passion of a pathetic tragedy; and, by proper representation, may be raised to a height scarce exceeded by any thing felt in real life. A moral tragedy takes in a larger field; as it not only exercises our pity, but raises another passion, which, though selfish, deserves to be cherished equally with the social affection. The passion we have in view is fear or terror; for when a misfortune is the natural consequence of some wrong bias in the temper, every spectator who is conscious of such a bias in himself takes the alarm, and dreads his falling into the same misfortune: and by the emotion of fear or terror, frequently reiterated in a variety of moral tragedies, the spectators are put upon their guard against the disorders of passion.

The commentators upon Aristotle, and other critics, have been much graver about the account given of tragedy by that author: "That by means of pity and terror, it refines or purifies in us all sorts of passion." But no one who has a clear conception of the end and effects of a good tragedy, can have any difficulty about Aristotle's meaning: Our pity is engaged for the persons represented; and our terror is upon our own account. Pity indeed is here made to stand for all the sympathetic emotions, because of these it is the capital. There can be no doubt, that our sympathetic emotions are refined or improved by daily exercise; and in what manner our other passions are refined by terror, has been just now said. One thing is certain, that no other meaning can justly be given to the foregoing doctrine than that now mentioned; and that it was really Aristotle's meaning, appears from his 13th chapter, where he delivers several propositions conformable to the doctrine as here explained. These, at the same time, we take liberty to mention; because, so far as authority can go, they confirm the foregoing reasoning about subjects proper for tragedy. The first proposition is, That it being the province of tragedy to excite pity and terror, an innocent person falling into adversity ought never to be the subject. This proposition is a necessary consequence of his doctrine as explained: a subject of that nature may indeed excite pity and terror; but the former in an inferior degree, and the latter in no degree for moral instruction. The second proposition is, That the history of a wicked person in a change from misery to happiness ought not to be represented; which excites neither terror nor compassion, nor is agreeable in any respect. The third is, That the misfortunes of a wicked person ought not to be represented: such representation may be agreeable in some measure

Of the
Epoëe and
Drama.

Of the
Epos and
Drama.

measure upon a principle of justice; but it will not move our pity; nor any degree of terror, except in those of the same vicious disposition with the person represented. The last proposition is, That the only character fit for representation lies in the middle, neither eminently good nor eminently bad; where the misfortune is not the effect of deliberate vice, but of some involuntary fault, as our author expresses it. The only objection we find to Aristotle's account of tragedy, is, that he confines it within too narrow bounds, by refusing admittance to the pathetic kind: for if terror be essential to tragedy, no representation deserves that name but the moral kind, where the misfortunes exhibited are caused by a wrong balance of mind, or some disorder in the internal constitution: such misfortunes always suggest moral instruction; and by such misfortunes only can terror be excited for our improvement.

Thus Aristotle's four propositions above-mentioned relate solely to tragedies of the moral kind. Those of the pathetic kind are not confined within so narrow limits: subjects fitted for the theatre are not in such plenty as to make us reject innocent misfortunes which rouse our sympathy, though they inculcate no moral. With respect indeed to the subjects of that kind, it may be doubted, whether the conclusion ought not always to be fortunate. Where a person of integrity is represented as suffering to the end under misfortunes purely accidental, we depart discontented, and with some obscure sense of injustice: for seldom is man so submissive to Providence, as not to revolt against the tyranny and vexations of blind chance; he will be tempted to say, this ought not to be. We give for an example the *Romeo and Juliet* of Shakespeare, where the fatal catastrophe is occasioned by Friar Laurence's coming to the monument a minute too late; we are vexed at the unlucky chance, and go away dissatisfied. Such impressions, which ought not to be cherished, are a sufficient reason for excluding stories of this kind from the theatre.

85
The improper use of destiny in the ancient tragedies.

The misfortunes of a virtuous person, arising from necessary causes, or a chain of unavoidable circumstances, as they excite a notion of destiny, are equally unsatisfactory to the human mind. A metaphysician in his closet may reason himself into the belief of fate, or what in modern language is called *philosophical necessity*; but the feelings of the heart revolt against that doctrine; and we have the confession of the two ablest philosophers by whom it was ever maintained, that men conduct themselves through life as if their will were absolutely free, and their actions no part of a chain of necessary causes and effects. As no man goes to the theatre to study metaphysics, or to divest himself of the common feelings of humanity, it is impossible, whatever be his philosophical creed, that he should contemplate without horror and disgust an innocent person suffering by mere destiny. A tragedy of uncommon merit in every other respect may indeed be endured, nay perhaps admired, though such be its catastrophe; because no work of man was ever perfect; and because, where imperfections are unavoidable, a multitude of excellencies may be allowed to cover one fault: but we believe the misery of an innocent person resulting from a chain of unavoidable circumstances has never been considered as a beauty by minds unperturbed by a false philosophy. "It must be acknowledged * that the subjects of the ancient Greek

* Blair.

tragedies were frequently founded on mere destiny and inevitable misfortunes. In the course of the drama many moral sentiments occurred; but the only instruction which the fable conveyed was, that reverence was due to the gods, and submission to the decrees of fate. Modern tragedy has aimed at a higher object, by becoming more the theatre of passion; pointing out to men the consequences of their own misconduct, showing the direful effects which ambition, jealousy, love, resentment, and other such strong emotions, when misguided or left unrestrained, produce upon human life. An Othello, hurried by jealousy to murder his innocent wife; a Jaffier ensnared by resentment and want to engage in a conspiracy, and then stung with remorse and involved in ruin; a Siffredi, through the deceit which he employs for public-spirited ends, bringing destruction on all whom he loved: these, and such as these, are the examples which Tragedy now displays to public view; and by means of which it inculcates on men the proper government of their passions."

Of the
Epos and
Drama.

There is indeed one singular drama, in which destiny is employed in a manner very different from that in which it was used by the poets of Greece and Rome. It is Schiller's Tragedy of the Robbers, of which "the hero, endowed by nature (as the translator of the piece observes) with the most generous feelings, animated by the highest sense of honour, and susceptible of the warmest affections of the heart, is driven by the perfidy of a brother, and the supposed inhumanity of his father, into a state of confirmed misanthropy and despair." He wishes that he "could blow the trumpet of rebellion through all nature; that he could extinguish with one mortal blow the viperous race of men; and that he could so strike as to destroy the germ of existence." In this situation he is hurried on to the perpetration of a series of crimes, which find from their very magnitude and atrocity a recommendation to his distempered mind. Sensible all the while of his own guilt, and suffering for that guilt the severest pangs of remorse, he yet believes himself an instrument of vengeance in the hand of the Almighty for the punishment of the crimes of others. In thus accomplishing the dreadful destiny which is prescribed for him, he feels a species of gloomy satisfaction, at the same time that he considers himself as doomed to the performance of that part in life which is to consign his memory to infamy and his soul to perdition. After burning a town, he exclaims, "O God of vengeance! am I to blame for this? Art thou to blame, O Father of Heaven! when the instruments of thy wrath, the pestilence, flood, and famine overwhelm at once the righteous and the guilty? Who can command the flames to stay their course, to destroy only the noxious vermin, and spare the fertile field?" yet with the same breath he accuses himself of extreme criminality for "presumptuously wicking the sword of the Most High!" He frequently laments in the most affecting manner the loss of his innocence, wishes that "he could return into the womb that bore him, that he hung an infant at the breast, that he were born a beggar, the meanest hind, a peasant of the field." He considers himself as the outcast of Heaven, and finally rejected by the Father of mercy; yet he tells the band of robbers whom he commanded, that the "Almighty honoured them as agents in his hands to execute his wondrous purposes; employed them as his angels to execute his stern decrees, and pour the vials

86
How it is used in the tragedy of the Robbers.

Of the
Epopée and
Drama

of his wrath;" and in a very solemn prayer, he supposes that "the God who ruleth over all had decreed that he should become the chief of these foul murderers."

"It will be allowed, says the translator, that the imagination could not have conceived a spectacle more deeply interesting, more powerfully affecting to the mind of man, than that of a human being thus characterised and acting under such impressions. The compassionate interest which the mind feels in the emotions or sufferings of the guilty person, is not diminished by the observation, that he acts under an impression of inevitable destiny; on the contrary, there is something in our nature which leads us the more to compassionate the instrument of those crimes, that we see him consider himself as bound to guilt by fetters, which he has the constant wish, but not the strength, to break."

This is indeed true: we sympathise with the hero of the Robbers, not only on account of his exalted sentiments and his inflexible regard to the abstract principles of honour and justice, but much more for that disorder of intellect which makes him suppose "his destiny fixed and unalterable," at the very time that he is torn with remorse for the perpetration of those crimes by which he believed it to be fulfilling. Destiny, however, is not in this tragedy exhibited as real, but merely as the phantom of a distempered though noble mind. Had the poet represented his hero as in *fact* decreed by God, or bound by fate, to head a band of foul murderers, and to commit a series of the most atrocious crimes; though our pity for him might not have been lessened, the impressions of the whole piece on the mind could have been only those of horror and disgust at what would have appeared to us the unequal ways of providence.

87
Whether
the subject
of tragedy
should have
its founda-
tion in
truth.

The Tragedy of the Robbers is a striking instance of the justness of Dr Blair's criticism, in opposition to that of Lord Kames. His lordship holds that it is essential to a good tragedy, that its principal facts be borrowed from history; because a mixture of known truth with the fable tends to delude us into a conviction of the reality of the whole. The Doctor considers this as a matter of no great consequence; for "it is proved by experience, that a fictitious tale, if properly conducted, will melt the heart as much as any real history;" this observation is verified in the Robbers. It is indeed a very irregular drama, and perhaps could not be acted on a British theatre. But although the whole is known to be a fiction, we believe there are few effusions of human genius which more powerfully excite the emotions of terror and pity. Truth is indeed congenial to the mind; and when a subject proper for tragedy occurs in history or tradition, it is perhaps better to adopt it than to invent one which has no such foundation. But in choosing a subject which makes a figure in history, greater precaution is necessary than where the whole is a fiction. In the latter case, the author is under no restraint other than that the characters and incidents be just copies of nature. But where the story is founded on truth, no circumstances must be added, but such as connect natu-

rally with what are known to be true; history may be supplied, but must not be contradicted. Further, the subject chosen must be distant in time, or at least in place; for the familiarity of recent persons and events ought to be avoided. Familiarity ought more especially to be avoided in an epic poem, the peculiar character of which is dignity and elevation: modern manners make but a poor figure in such a poem. Their familiarity unqualifies them for a lofty subject. The dignity of them will be better understood in future ages, when they are no longer familiar.

After Voltaire, no writer, it is probable, will think of rearing an epic poem upon a recent event in the history of his own country. But an event of that kind is perhaps not altogether unqualified for tragedy: it was admitted in Greece; and Shakespeare has employed it successfully in several of his pieces. One advantage it possesses above fiction, that of more readily engaging our belief, which tends above any other particular to raise our sympathy. The scene of comedy is generally laid at home: familiarity is no objection; and we are peculiarly sensible of the ridicule of our own manners.

88
After a proper subject is chosen, the dividing it into parts requires some art. The conclusion of a book in an epic poem, or of an act in a play, cannot be altogether arbitrary; nor be intended for so slight a purpose as to make the parts of equal length. The supposed pause at the end of every book, and the real pause at the end of every act, ought always to coincide with some pause in the action. In this respect, a dramatic or epic poem ought to resemble a sentence or period in language, divided into members that are distinguished from each other by proper pauses; or it ought to resemble a piece of music, having a full close at the end, preceded by imperfect closes that contribute to the melody. The division of every play into *five* acts has no other foundation than common practice, and the authority of Horace (p). It is a division purely arbitrary; there is nothing in the nature of the composition which fixes this number rather than any other; and it had been much better if no such number had been ascertained. But, since it is ascertained, every act in a dramatic poem ought to close with some incident that makes a pause in the action; for otherwise there can be no pretext for interrupting the representation. It would be absurd to break off in the very heat of action; against which every one would exclaim: the absurdity still remains where the action relents, if it be not actually suspended for some time. This rule is also applicable to an epic poem: though in it a deviation from the rule is less remarkable; because it is in the reader's power to hide the absurdity, by proceeding instantly to another book. The first book of *Paradise Lost* ends without any close, perfect or imperfect: it breaks off abruptly, where Satan, seated on his throne, is prepared to harangue the convoked host of the fallen angels; and the second book begins with the speech. Milton seems to have copied the *Æneid*, of which the two first books are divided much in the same

Of the
Epopée and
Drama.

(D) *Neve minor, neu sit quinto producior actu
Fabula.*

DE ARTE POETICA.

If you would have your play deserve success,
Give it five acts complete, nor more nor less. *Francis.*

Of the
Epoee and
Drama.89
The object
of comedyBlair's
Lectures.90
Comedy of
two kinds.91
The com-
mon faults
of comedy.

same manner. Neither is there any proper pause at the end of the seventh book of *Paradise Lost*, nor at the end of the eleventh. In the *Iliad* little attention is given to this rule.

Besides tragedy, dramatic poetry comprehends comedy and farce. These are sufficiently distinguished from tragedy by their general spirit and strain. "While pity and terror, and the other strong passions, form the province of the tragic muse, the chief or rather sole instrument of comedy and farce is ridicule." These two species of composition are so perpetually running into each other, that we shall not treat of them separately; since what is now known by the name of *farce* differs in nothing essential from what was called the *old comedy* among the Greeks. "Comedy proposes for its object neither the great sufferings nor the great crimes of men; but their follies and slighter vices, those parts of their character which raise in beholders a sense of impropriety, which expose them to be censured and laughed at by others, or which render them troublesome in civil society.

"The subjects of tragedy are not limited to any age or country; but the scene and subject of comedy should always be laid in our own country, and in our own times. The reason is obvious: those decorums of behaviour, those lesser discriminations of character, which afford subject for comedy, change with the differences of countries and times; and can never be so well understood by foreigners as by natives. The comic poet, who aims at correcting improprieties and follies of behaviour, should 'catch the manners living as they rise.' It is not his business to amuse us with a tale of other times; but to give us pictures taken from among ourselves; to satirize reigning and present vices; to exhibit to the age a faithful copy of itself, with its humours, its follies, and its extravagancies.

"Comedy may be divided into two kinds: comedy of *character*, and comedy of *intrigue*. The former is the more valuable species; because it is the business of comedy to exhibit the prevailing manners, which mark the character of the age in which the scene is laid: yet there should be always as much intrigue as to give us something to wish and something to fear. The incidents should so succeed one another, as to produce striking situations, and to fix our attention; while they afford at the same time a proper field for the exhibition of character. The action in comedy, though it demands the poet's care in order to render it animated and natural, is a less significant and important part of the performance than the action in tragedy: as in comedy it is what men say, and how they behave, that draws our attention, rather than what they perform or what they suffer.

"In the management of characters, one of the most common faults of comic writers is the carrying of them too far beyond life. Wherever ridicule is concerned, it is indeed extremely difficult to hit the precise point where true wit ends and buffoonery begins. When the miser in *Plautus*, searching the person whom he suspects of having stolen his casket, after examining first his right hand and then his left, cries out, *ostende etiam tertiam*—'show me your third hand,' there is no one but must be sensible of the extravagance. Certain degrees of exaggeration are allowed to the comedian, but there are limits set to it by nature and good taste; and supposing the miser to be ever so much engrossed by his jealousy

and his suspicions, it is impossible to conceive any man in his wits suspecting another of having more than two hands."

It appears from the plays of *Aristophanes* which remain, that the characters in the old comedy of Athens were almost always overcharged. They were likewise direct and avowed satires against particular persons, who were brought upon the stage by name. "The ridicule employed in them is extravagant, the wit for the most part buffoonish and farcical, the raillery biting and cruel, and the obscenity that reigns in them is gross and intolerable. They seem to have been composed merely for the mob." Yet of these abominable dramas, an excellent critic * has affirmed, with too much truth, that what is now called *farce* is nothing more than the shadow. The characters in genuine comedy are not those of particular and known persons, but the general characters of the age and nation; which it requires no small skill to distinguish clearly and naturally from each other. In attempting this, poets are too apt to contrast characters and introduce them always in pairs; which gives an affected air to the whole piece. The perfection of art is to conceal art. "A matterly writer will give us his characters distinguished rather by such shades of diversity as are commonly found in society, than marked with such strong oppositions as are rarely brought into actual contrast in any of the circumstances of real life."

The style of comedy ought to be pure, elegant, lively, very seldom rising higher than the ordinary tone of polite conversation; and upon no occasion descending into vulgar, mean, and gross expressions; and in one word, action and character being the fundamental parts of every epic and dramatic composition, the sentiments and tone of language ought to be subservient to these, so as to appear natural and proper for the occasion.

§ 2. *Respective peculiarities of the Epoee and Drama.*

In a theatrical entertainment, which employs both the eye and the ear, it would be a gross absurdity to introduce upon the stage superior beings in a visible shape. There is no place for such objection in an *epic poem*; and *Boileau*, with many other critics, declares strongly for that sort of machinery in an epic poem. But waving authority, which is apt to impose upon the judgement, let us draw what light we can from reason. We may in the first place observe, that this matter is but indistinctly handled by critics: the poetical privilege of animating insensible objects for enlivening a description, is very different from what is termed *machinery*, where deities, angels, devils, or other supernatural powers, are introduced as real personages, mixing in the action, and contributing to the catastrophe; and yet these two things are constantly jumbled together in reasoning. The former is founded on a natural principle: but nothing is more unnatural than the latter. Its effects, at the same time, are deplorable. First, it gives an air of fiction to the whole; and prevents that impression of reality which is requisite to interest our affections, and to move our passions; which of itself is sufficient to explode machinery, whatever entertainment it may afford to readers of a fantastic taste or irregular imagination. And, next, were it possible, by disguising the fiction, to delude us into a notion of reality, an insuperable objection would still remain, which is, that the aim or end of

Of the
Epoee.* *Hurd*.92
The style
of comedy.93
Machinery
can have
no place in
a drama,
nor94
Has it a
good effect
in the
higher epic.

an

Of the
Epoëe.

an epic poem can never be attained in any perfection where machinery is introduced; for an evident reason, that virtuous emotions cannot be raised successfully but by the actions of those who are endued with passions and affections like our own, that is, by human actions; and as for moral instruction, it is clear, that none can be drawn from beings who act not upon the same principles with us. A fable in *Æsop's* manner is no objection to this reasoning: his lions, bulls, and goats, are truly men under disguise; they act and feel in every respect as human beings; and the moral we draw is founded on that supposition. Homer, it is true, introduces the gods into his fable: but the religion of his country authorized that liberty; it being an article in the Grecian creed, that the gods often interpose visibly and bodily in human affairs. It must however be observed, that Homer's deities do no honour to his poems; fictions that transgress the bounds of nature, seldom have a good effect; they may inflame the imagination for a moment, but will not be relished by any person of a correct taste. They may be of some use to the lower rank of writers; but an author of genius has much finer materials, of Nature's production, for elevating his subject, and making it interesting.

One would be apt to think, that Boileau, declaring for the Heathen deities, intended them only for embellishing the diction: but unluckily he banishes angels and devils, who undoubtedly make a figure in poetic language, equal to the Heathen deities. Boileau, therefore, by pleading for the latter in opposition to the former, certainly meant, if he had any distinct meaning, that the Heathen deities may be introduced as actors. And, in fact, he himself is guilty of that glaring absurdity, where it is not so pardonable as in an epic poem: In his ode upon the taking of Namur, he demands with a most serious countenance, whether the walls were built by Apollo or Neptune: and in relating the passage of the Rhine, anno 1672, he describes the god of that river as fighting with all his might to oppose the French monarch; which is confounding fiction with reality at a strange rate. The French writers in general run into this error: wonderful the effect of custom, entirely to hide from them how ridiculous such fictions are.

That this is a capital error in *Gierusalemme Liberata*, Tasso's greatest admirers must acknowledge: a situation can never be intricate, nor the reader ever in pain about the catastrophe, so long as there is an angel, devil, or magician, to lend a helping hand. Voltaire, in his essay upon epic poetry, talking of the *Pharsalia*, observes judiciously, "That the proximity of time, the notoriety of events, the character of the age, enlightened and political, joined with the solidity of Lucan's subject, deprived him of poetical fiction." Is it not amazing, that a critic who reasons so justly with respect to others, can be so blind with respect to himself? Voltaire, not satisfied to enrich his language with images drawn from invisible and superior beings, introduces them into the action: in the sixth canto of the *Tienriade*, St Louis appears in person, and terrifies the soldiers; in the seventh canto, St Louis sends the god of Sleep to Henry; and, in the tenth, the demons of Discord, Fanaticism, War, &c. assist Aumale in a single combat with Turenne, and are driven away by a good angel brandishing the sword of God. To blend such fictitious personages

in the same action with mortals, makes a bad figure at any rate; and is intolerable in a history so recent as that of Henry IV. But perfection is not the lot of man.

But perhaps the most successful weapon that can be employed upon this subject is ridicule. Addison has applied this in an elegant manner: "Whereas the time of a general peace is, in all appearance, drawing near; being informed that there are several ingenious persons who intend to show their talents on so happy an occasion, and being willing, as much as in me lies, to prevent that effusion of nonsense which we have good cause to apprehend; I do hereby strictly require every person who shall write on this subject, to remember that he is a Christian, and not to sacrifice his catechism to his poetry. In order to it, I do expect of him, in the first place, to make his own poem, without depending upon Phœbus for any part of it, or calling out for aid upon any of the Muses by name. I do likewise positively forbid the sending of Mercury with any particular message or dispatch relating to the peace; and shall by no means suffer Minerva to take upon her the shape of any plenipotentiary concerned in this great work. I do further declare, that I shall not allow the Destinies to have had a hand in the deaths of the several thousands who have been slain in the late war; being of opinion that all such deaths may be well accounted for by the Christian system of powder and ball. I do therefore strictly forbid the Fates to cut the thread of man's life upon any pretence whatsoever, unless it be for the sake of rhyme. And whereas I have good reason to fear, that Neptune will have a great deal of business on his hands in several poems which we may now suppose are upon the anvil, I do also prohibit his appearance, unless it be done in metaphor, simile, or any very short allusion; and that even here he may not be permitted to enter, but with great caution and circumspection. I desire that the same rule may be extended to his whole fraternity of Heathen gods; it being my design to condemn every poem to the flames in which Jupiter thunders, or exercises any other act of authority which does not belong to him. In short, I expect that no Pagan agent shall be introduced, or any fact related which a man cannot give credit to with a good conscience. Provided always, that nothing herein contained shall extend, or be construed to extend, to several of the female poets in this nation, who shall still be left in full possession of their gods and goddesses, in the same manner as if this paper had never been written." *Spec. n.º 523.*

The marvellous is indeed so much promoted by machinery, that it is not wonderful to find it embraced by the bulk of writers, and perhaps of readers. If indulged at all, it is generally indulged to excess. Homer introduceth his deities with no greater ceremony than his mortals; and Virgil has still less moderation: a pilot spent with watching cannot fall asleep and drop into the sea by natural means: one bed cannot receive the two lovers *Æneas* and *Dido*, without the immediate interposition of superior powers. The ridiculous in such fictions must appear even through the thickest veil of gravity and solemnity.

Angels and devils serve equally with Heathen deities as materials for figurative language; perhaps better among Christians, because we believe in them, and not

Of the
Epoëe.

Of the
Epoëe.

in Heathen deities. But every one is sensible, as well as Boileau, that the invisible powers in our creed make a much worse figure as actors in a modern poem than the invisible powers in the Heathen creed did in ancient poems; the cause of which is not far to seek. The Heathen deities, in the opinion of their votaries, were beings elevated one step only above mankind, subject to the same passions, and directed by the same motives; therefore not altogether improper to mix with men in an important action. In our creed, superior beings are placed at such a mighty distance from us, and are of a nature so different, that with no propriety can we appear with them upon the same stage: man, a creature much inferior, loses all dignity in the comparison.

95
an histori-
al poem
omits of
allegory.
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proper re-
strictions.

There can be no doubt that an historical poem admits the embellishment of allegory as well as of metaphor, simile, or other figure. Moral truth, in particular, is finely illustrated in the allegorical manner: it amuses the fancy to find abstract terms, by a sort of magic, metamorphosed into active beings; and it is delightful to trace a general proposition in a pictured event. But allegorical beings should be confined within their own sphere, and never be admitted to mix in the principal action, nor to co-operate in retarding or advancing the catastrophe; which would have a still worse effect than invisible powers: for the impression of real existence, essential to an epic poem, is inconsistent with that figurative existence which is essential to an allegory; and therefore no method can more effectually prevent the impression of reality than the introduction of allegorical beings co-operating with those whom we conceive to be really existing. The love-episode in the *Henriade* (canto 9.), insufferable by the discordant mixture of allegory with real life, is copied from that of Rinaldo and Armida in the *Jerusalemme Liberata*, which hath no merit to intitle it to be copied. An allegorical object, such as Fame in the *Æneid*, and the Temple of Love in the *Henriade*, may find place in a description: but to introduce Discord as a real personage, imploring the assistance of Love as another real personage, to enervate the courage of the hero, is making these figurative beings act beyond their sphere, and creating a strange jumble of truth and fiction. The allegory of Sin and Death in the *Paradise Lost* is possibly not generally relished, though it is not entirely of the same nature with what we have been condemning; in a work comprehending the achievements of superior beings there is more room for fancy than where it is confined to human actions.

96
Episode de-
fined.

What is the true notion of an episode? or how is it to be distinguished from the principal action? Every incident that promotes or retards the catastrophe must be part of the principal action. This clears the nature of an episode; which may be defined, "An incident connected with the principal action, but contributing neither to advance nor retard it." The descent of *Æneas* into hell does not advance nor retard the catastrophe, and therefore is an episode. The story of *Nisus* and *Euryalus*, producing an alteration in the affairs of the contending parties, is a part of the principal action.

The family-scene in the sixth book of the *Iliad* is of the same nature; for by *Hector's* retiring from the field of battle to visit his wife, the Grecians had opportunity to breathe, and even to turn upon the Trojans. The unavoidable effect of an episode according to this definition must be, to break the unity of action; and therefore it ought never to be indulged unless to unbend the mind after the fatigue of a long narration. An episode, when such is its purpose, requires the following conditions: it ought to be well connected with the principal action; it ought to be lively and interesting; it ought to be short; and a time ought to be chosen when the principal action relents (E).

Of the
Epoëe.

97
What con-
stitutes a
good epi-
sode.

In the following beautiful episode, which closes the second book of *Fingal*, all these conditions are united.

"Comal was a son of Albion; the chief of an hundred hills. His deer drunk of a thousand streams; and a thousand rocks replied to the voice of his dogs. His face was the mildness of youth; but his hand the death of heroes. One was his love, and fair was she! the daughter of mighty Conloch. She appeared like a sun-beam among women, and her hair was like the wing of the raven. Her soul was fixed on Comal, and she was his companion in the chace. Often met their eyes of love, and happy were their words in secret. But Gormal loved the maid, the chief of gloomy Ardven. He watched her lone steps on the heath, the foe of unhappy Comal."

"One day, tired of the chace, when the mist had concealed their friends, Comal and the daughter of Conloch met in the cave of Ronan. It was the wonted haunt of Comal. Its sides were hung with his arms; a hundred shields of thongs were there, a hundred helms of sounding steel. Rest here, said he, my love Galvina, thou light of the cave of Ronan: a deer appears on Mora's brow; I go, but soon will return. I fear, said she, dark Gormal my foe: I will rest here; but soon return, my love."

"He went to the deer of Mora. The daughter of Conloch, to try his love, clothed her white side with his armour, and strode from the cave of Ronan. Thinking her his foe, his heart beat high, and his colour changed. He drew the bow: the arrow flew: Galvina fell in blood. He ran to the cave with hasty steps, and called the daughter of Conloch. Where art thou, my love? but no answer.—He marked, at length, her heaving heart beating against the mortal arrow. O Conloch's daughter, is it thou!—he sunk upon her breast."

"The hunters found the hapless pair. Many and silent were his steps round the dark dwellings of his love. The fleet of the ocean came: he fought, and the strangers fell: he searched for death over the field; but who could kill the mighty Comal? Throwing away his shield, an arrow found his manly breast. He sleeps with his Galvina: their green tombs are seen by the mariner when he bounds on the waves of the north."

Next, upon the peculiarities of a dramatic poem. And the

(E) Homer's description of the shield of Achilles is properly introduced at a time when the action relents, and the reader can bear an interruption. But the author of *Telemachus* describes the shield of that young hero in the heat of battle; a very improper time for an interruption.

Of the
Drama.

98

Double plot
in a drama
seldom
successful.

the first we shall mention is a double plot: one of which must resemble an episode in an epic poem; for it would distract the spectator, instead of entertaining him, if he were forced to attend at the same time to two capital plots equally interesting. And even supposing it an under-plot like an episode, it seldom hath a good effect in tragedy, of which simplicity is a chief property; for an interesting subject that engages our affections, occupies our whole attention, and leaves no room for any separate concern. Variety is more tolerable in comedy; which pretends only to amuse, without totally occupying the mind. But even there, to make a double plot agreeable, is no slight effort of art: the under-plot ought not to vary greatly in its tone from the principal; for discordant emotions are unpleasant when jumbled together; which, by the way, is an insuperable objection to tragi-comedy. Upon that account the Provok'd Husband deserves censure; all the scenes that bring the family of the Wrongheads into action, being ludicrous and farical, are in a very different tone from the principal scenes, displaying severe and bitter expostulations between Lord Townley and his lady. The same objection touches not the double plot of the Careless Husband; the different subjects being sweetly connected, and having only so much variety as to resemble shades of colours harmoniously mixed. But this is not all. The under-plot ought to be connected with that which is principal, so much at least as to employ the same persons: the under-plot ought to occupy the intervals or pauses of the principal action; and both ought to be concluded together. This is the case of the Merry Wives of Windsor.

99

Violent action
ought
not to be
represented.

Violent action ought never to be represented on the stage. While the dialogue goes on, a thousand particulars concur to delude us into an impression of reality; genuine sentiments, passionate language, and persuasive gesture: the spectator, once engaged, is willing to be deceived, loses sight of himself, and without scruple enjoys the spectacle as a reality. From this absent state he is roused by violent action; he wakes as from a pleasing dream; and, gathering his senses about him, finds all to be a fiction. Horace delivers the same rule; and founds it upon the same reason:

Ne pueros coram populo Medea trucidet;
Aut humana palam coquat nefarius Atræus;
Aut in avem Progne vertatur, Cadmus in anguem:
Quodcumque ostendis mihi sic, incredulus odi.

The French critics join with Horace in excluding blood from the stage; but overlooking the most substantial objection, they urge only that it is barbarous and shocking to a polite audience. The Greeks had no notion of such delicacy, or rather effeminacy; witness the murder of Clytemnestra by her son Orestes, passing behind the scene, as represented by Sophocles: her voice is heard calling out for mercy, bitter expostulations on his part, loud shrieks upon her being stabbed, and then a deep silence. An appeal may be made to every person of feeling, whether this scene be not more horrible than if the deed had been committed in sight of the spectators upon a sudden gust of passion. If Corneille, in representing the affair between Horatius and his sister, upon which the murder ensues behind the scene, had no other view but to remove from the spectators a shocking action, he was guilty of a capital mistake: for murder

in cold blood, which in some measure was the case as represented, is more shocking to a polite audience, even where the conclusive stab is not seen, than the same act performed in their presence by violent and unpremeditated passion, as suddenly repented of as committed. Addison's observation is just †, That no part of this incident ought to have been represented, but reserved for a narrative, with every alleviating circumstance in favour of the hero.

A few words upon the dialogue, which ought to be so conducted as to be a true representation of nature. We talk not here of the sentiments nor of the language (which are treated elsewhere): but of what properly belongs to dialogue-writing; where every single speech, short or long, ought to arise from what is said by the former speaker, and furnish matter for what comes after till the end of the scene. In this view, all the speeches from first to last represent so many links of one regular chain. No author, ancient or modern, possesses the art of dialogue equal to Shakespeare. Dryden, in that particular, may justly be placed as his opposite. He frequently introduces three or four persons speaking upon the same subject, each throwing out his own notions separately, without regarding what is said by the rest: take for an example the first scene of Aurenzebe. Sometimes he makes a number club in relating an event, not to a stranger, supposed ignorant of it, but to one another, for the sake merely of speaking: of which notable sort of dialogue we have a specimen in the first scene of the first part of the Conquest of Granada. In the second part of the same tragedy, scene second, the King, Abenamar, and Zulema, make their separate observations, like so many soliloquies, upon the fluctuating temper of the mob: a dialogue so uncouth puts one in mind of two shepherds in a pastoral excited by a prize to pronounce verses alternately, each in praise of his own mistress.

This manner of dialogue-writing, beside an unnatural air, has another bad effect: it stays the course of the action, because it is not productive of any consequence. In Congreve's comedies, the action is often suspended to make way for a play of wit.

No fault is more common among writers than to prolong a speech after the impatience of the person to whom it is addressed ought to prompt him or her to break in. Consider only how the impatient actor is to behave in the mean time. To express his impatience in violent action without interrupting would be unnatural; and yet to dissemble his impatience, by appearing cool where he ought to be highly inflamed, would be no less so.

Rhyme being unnatural and disgustful in dialogue, is happily banished from our theatre: the only wonder is that it ever found admittance, especially among a people accustomed to the more manly freedom of Shakespeare's dialogue. By banishing rhyme, we have gained so much as never once to dream that there can be any further improvement. And yet, however suitable blank verse may be to elevated characters and warm passions, it must appear improper and affected in the mouths of the lower sort. Why then should it be a rule, That every scene in tragedy must be in blank verse? Shakespeare, with great judgment, has followed a different rule; which is, to intermix prose with verse, and only to employ the latter where it is required by the importance or dignity of the subject. Familiar thoughts and ordinary facts ought to be expressed in plain language: to hear, for example,

Of the
Drama.† Spectator,
No 44.100
The proper
conduct of
the dia-
logue.

The three Unities.

a footman deliver a simple message in blank verse must appear ridiculous to every one who is not biased by custom. In short, that variety of characters and of situations, which is the life of a play, requires not only a suitable variety in the sentiments, but also in the diction.

§ 3. *The Three Unities.*

WHEN we consider the chain of causes and effects in the material world, independent of purpose, design, or thought, we find a number of incidents in succession, without beginning, middle, or end: every thing that happens is both a cause and an effect; being the effect of what goes before, and the cause of what follows: one incident may affect us more, another less; but all of them are links in the universal chain: the mind, in viewing these incidents, cannot rest or settle ultimately upon any one; but is carried along in the train without any close.

101
In what the unity of action consists.

But when the intellectual world is taken under view, in conjunction with the material, the scene is varied. Man acts with deliberation, will, and choice: he aims at some end; glory, for example, or riches, or conquest, the procuring happiness to individuals, or to his country in general: he proposes means, and lays plans to attain the end proposed. Here are a number of facts or incidents leading to the end in view, the whole composing one chain by the relation of cause and effect. In running over a series of such facts or incidents, we cannot rest upon any one; because they are presented to us as means only, leading to some end: but we rest with satisfaction upon the end or ultimate event; because there the purpose or aim of the chief person or persons is accomplished. This indicates the beginning, the middle, and the end, of what Aristotle calls *an entire action* *. The story naturally begins with describing those circumstances which move the person who acts the principal part to form a plan, in order to compass some desired event; the prosecution of that plan, and the obstructions, carry the reader into the heat of action; the middle is properly where the action is the most involved; and the end is where the event is brought about, and the plan accomplished.

* Poet. c. 6.

We have given the foregoing example of a plan crowned with success, because it affords the clearest conception of a beginning, a middle, and an end, in which consists unity of action; and indeed stricter unity cannot be imagined than in that case. But an action may have unity, or a beginning, middle, and end, without so intimate a relation of parts; as where the catastrophe is different from what is intended or desired, which frequently happens in our best tragedies. In the *Æneid*, the hero, after many obstructions, makes his plan effectual. The *Iliad* is formed upon a different model: it begins with the quarrel between Achilles and Agamemnon; goes on to describe the several effects produced by that cause; and ends in a reconciliation. Here is unity of action, no doubt, a beginning, a middle, and an end; but inferior to that of the *Æneid*, which will thus appear. The mind hath a propensity to go forward in the chain of history; it keeps always in view the expected event; and when the incidents or underparts are connected by their relation to the event, the mind runs sweetly and easily along them. This pleasure we have in the *Æneid*. It is not altogether so

VOL. XV. Part I.

pleasant to connect, as in the *Iliad*, effects by their common cause; for such connection forces the mind to a continual retrospect: looking backward is like walking backward.

The three Unities.

102

If unity of action be a capital beauty in fable imitative of human affairs, a plurality of unconnected fables must be a capital deformity. For the sake of variety, we indulge an under-plot that is connected with the principal: but two unconnected events are extremely unpleasant, even where the same actors are engaged in both. Ariosto is quite licentious in that particular: he carries on at the same time a plurality of unconnected stories. His only excuse is, that his plan is perfectly well adjusted to his subject; for every thing in the *Orlando Furioso* is wild and extravagant.

Unity of action a capital beauty.

Though to state facts in the order of time is natural, yet that order may be varied for the sake of conspicuous beauties. If, for example, a noted story, cold and simple in its first movements, be made the subject of an epic poem, the reader may be hurried into the heat of action; reserving the preliminaries for a conversation-piece, if thought necessary: and that method, at the same time, hath a peculiar beauty from being dramatic. But a privilege that deviates from nature ought to be sparingly indulged; and yet romance-writers make no difficulty of presenting to the reader, without the least preparation, unknown persons engaged in some arduous adventure equally unknown. In *Cassandra*, two personages, who afterwards are discovered to be the heroes of the fable, start up completely armed upon the banks of the Euphrates, and engage in a single combat.

A play analysed is a chain of connected facts, of which each scene makes a link. Each scene, accordingly, ought to produce some incident relative to the catastrophe or ultimate event, by advancing or retarding it. A scene that produceth no incident, and for that reason may be termed *barren*, ought not to be indulged, because it breaks the unity of action: a barren scene can never be intitled to a place, because the chain is complete without it. In the *Old Bachelor*, the 3d scene of act 2. and all that follow to the end of that act, are mere conversation-pieces, productive of no consequence. The 10th and 11th scenes, act 3. Double Dealer, and the 10th, 11th, 12th, 13th, and 14th scenes, act 1. *Love for Love*, are of the same kind. Neither is *The Way of the World* entirely guiltless of such scenes. It will be no justification that they help to display characters: it were better, like Dryden in his *dramatis personæ*, to describe characters beforehand, which would not break the chain of action. But a writer of genius has no occasion for such artifice: he can display the characters of his personages much more to the life in sentiment and action. How successfully is this done by Shakespeare! in whose works there is not to be found a single barren scene.

Upon the whole, it appears, that all the facts in an historical fable ought to have a mutual connection, by their common relation to the grand event or catastrophe. And this relation, in which the unity of action consists, is equally essential to epic and dramatic compositions.

How far the unities of time and of place are essential, is a question of greater intricacy. These unities were strictly observed in the Greek and Roman theatres; and they are inculcated by the French and English critics as essential to every dramatic composition. In theory

103
Whether unity of time and place be essential.

D d

these

Elem. of Criticism.

The three
Unities.

these unities are also acknowledged by our best poets, though their practice seldom corresponds: they are often forced to take liberties, which they pretend not to justify, against the practice of the Greeks and Romans, and against the solemn decision of their own countrymen. But in the course of this inquiry it will be made evident, that in this article we are under no necessity to copy the ancients; and that our critics are guilty of a mistake, in admitting no greater latitude of place and time than was admitted in Greece and Rome.

Indeed the unities of place and time are not, by the most rigid critics, required in a narrative poem. In such composition, if it pretend to copy nature, these unities would be absurd; because real events are seldom confined within narrow limits either of place or of time: and yet we can follow history, or an historical fable, through all its changes, with the greatest facility: we never once think of measuring the real time by what is taken in reading; nor of forming any connection between the place of action and that which we occupy.

We are aware, that the drama differs so far from the epic as to admit different rules. It will be observed, "That an historical fable, intended for reading solely, is under no limitation of time or of place more than a genuine history; but that a dramatic composition cannot be accurately represented unless it be limited, as its representation is, to one place and to a few hours; and therefore that no fable can be admitted but what has these properties, because it would be absurd to compose a piece for representation that cannot be justly represented." This argument has at least a plausible appearance; and yet one is apt to suspect some fallacy, considering that no critic, however strict, has ventured to confine the unities of place and of time within so narrow bounds.

A view of the Grecian drama, compared with our own, may perhaps relieve us from this dilemma: if they be differently constructed, as shall be made evident, it is possible that the foregoing reasoning may not be equally applicable to both.

104
They were
essential to
the Greek
drama, but

All authors agree, that tragedy in Greece was derived from the hymns in praise of Bacchus, which were sung in parts by a chorus. Thespis, to relieve the singers, and for the sake of variety, introduced one actor, whose province it was to explain historically the subject of the song, and who occasionally represented one or other personage. Eschylus, introducing a second actor, formed the dialogue; by which the performance became dramatic; and the actors were multiplied when the subject represented made it necessary. But still the chorus, which gave a beginning to tragedy, was considered as an essential part. The first scene, generally, unfolds the preliminary circumstances that lead to the grand event; and this scene is by Aristotle termed the *prologue*. In the second scene, where the action properly begins, the chorus is introduced, which, as originally, continues upon the stage during the whole performance: the chorus frequently makes one in the dialogue; and when the dialogue happens to be suspended, the chorus, during the interval, is employed in singing. Sophocles adheres to this plan religiously. Euripides is not altogether so correct. In some of his pieces it becomes necessary to remove the chorus for a little time: but when that unusual step is risked, matters are so ordered, as not to interrupt the representation: the chorus never leave the stage of their own accord, but at the

command of some principal personage, who constantly waits their return.

The three
Unities.

Thus the Grecian drama is a continued representation without any interruption; a circumstance that merits attention. A continued representation without a pause affords not opportunity to vary the place of action, nor to prolong the time of the action beyond that of the representation. To a representation so confined in place and time, the foregoing reasoning is strictly applicable: a real or feigned action, that is brought to a conclusion after considerable intervals of time and frequent changes of place, cannot accurately be copied in a representation that admits no latitude in either. Hence it is, that the unities of place and of time, were, or ought to have been, strictly observed in the Greek tragedies; which is made necessary by the very constitution of their drama, for it is absurd to compose a tragedy that cannot be justly represented.

Modern critics, who for our drama pretend to establish rules founded on the practice of the Greeks, are guilty of an egregious blunder. The unities of place and of time were in Greece, as we see, a matter of necessity, not of choice; and it is easy to show, that if we submit to such fetters, it must be from choice, not necessity. This will be evident upon taking a view of the constitution of our drama, which differs widely from that of Greece; whether more or less perfect, is a different point, to be handled afterward. By dropping the chorus, opportunity is afforded to divide the representation by intervals of time, during which the stage is evacuated and the spectacle suspended. This qualifies our drama for subjects spread through a wide space both of time and of place: the time supposed to pass during the suspension of the representation is not measured by the time of the suspension; and any place may be supposed, as it is not in sight: by which means, many subjects can justly be represented in our theatres, that were excluded from those of ancient Greece. This doctrine may be illustrated, by comparing a modern play to a set of historical pictures; let us suppose them five in number, and the resemblance will be complete: each of the pictures resembles an act in one of our plays: there must necessarily be the strictest unity of place and of time in each picture; and the same necessity requires these two unities during each act of a play, because during an act there is no interruption in the spectacle. Now, when we view in succession a number of such historical pictures, let it be, for example, the history of Alexander by Le Brun, we have no difficulty to conceive, that months or years have passed between the events exhibited in two different pictures, though the interruption is imperceptible in passing our eye from the one to the other; and we have as little difficulty to conceive a change of place, however great: in which view, there is truly no difference between five acts of a modern play and five such pictures. Where the representation is suspended, we can with the greatest facility suppose any length of time or any change of place: the spectator, it is true, may be conscious, that the real time and place are not the same with what are employed in the representation; but this is a work of reflection; and by the same reflection he may also be conscious, that Garrick is not King Lear, that the playhouse is not Dover cliffs, nor the noise he hears thunder and lightning. In a word, after an interruption of the representation, it is not

105
Not to the
French or
English.

more

The three
Unities.

more difficult for a spectator to imagine a new place, or a different time, than, at the commencement of the play, to imagine himself at Rome, or in a period of time two thousand years back. And indeed, it is abundantly ridiculous, that a critic, who is willing to hold candle-light for sun-shine, and some painted canvasses for a palace or a prison, should affect so much difficulty in imagining a latitude of place or of time in the fable, beyond what is necessary in the representation.

106
Great latitude in time, however, not to be indulged,

There are, it must be acknowledged, some effects of great latitude in time that ought never to be indulged in a composition for the theatre: nothing can be more absurd, than at the close to exhibit a full-grown person who appears a child at the beginning: the mind rejects, as contrary to all probability, such latitude of time as is requisite for a change so remarkable. The greatest change from place to place hath not altogether the same bad effect: in the bulk of human affairs place is not material; and the mind, when occupied with an interesting event, is little regardful of minute circumstances: these may be varied at will, because they scarce make any impression.

107
Nor in place.

At the same time, it is not here meant to justify liberty without any reserve. An unbounded licence with relation to place and time, is faulty, for a reason that seems to have been overlooked, which is, that it seldom fails, to break the unity of action; in the ordinary course of human affairs, single events, such as are fit to be represented on the stage, are confined to a narrow spot, and generally employ no great extent of time: we accordingly seldom find strict unity of action in a dramatic composition, where any remarkable latitude is indulged in these particulars. It may even be admitted, that a composition which employs but one place, and requires not a greater length of time than is necessary for the representation, is so much the more perfect; because the confining an event within so narrow bounds, contributes to the unity of action, and also prevents that labour, however slight, which the mind must undergo in imagining frequent changes of place, and many intervals of time. But still we must insist, that such limitation of place and time as was necessary in the Grecian drama, is no rule to us; and therefore, that though such limitation adds one beauty more to the composition, it is at best but a refinement, which may justly give place to a thousand beauties more substantial. And we may add, that it is extremely difficult, if not impracticable, to contract within the Grecian limits any fable so fruitful of incidents in number and variety as to give full scope to the fluctuation of passion.

Flem. of
Criticism,
ch. 23.

It may now appear, that critics who put the unities of place and of time upon the same footing with the unity of action, making them all equally essential, have not attended to the nature and constitution of the modern drama. If they admit an interrupted representation, with which no writer finds fault, it is absurd to reject its greatest advantage, that of representing many interesting subjects excluded from the Grecian stage. If there needs must be a reformation, why not restore the ancient chorus and the ancient continuity of action? There is certainly no medium; for to admit an interruption without relaxing from the strict unities of place and of time, is in effect to load us with all the inconveniences of the ancient drama, and at the same time to withhold from us its advantages.

And therefore the only proper question is, Whether our model be or be not a real improvement? This indeed may fairly be called in question; and in order to a comparative trial, some particulars must be premised. When a play begins, we have no difficulty to adjust our imagination to the scene of action, however distant it be in time or in place; because we know that the play is a representation only. The case is very different after we are engaged: it is the perfection of representation to hide itself, to impose on the spectator, and to produce in him an impression of reality, as if he were spectator of a real event; but any interruption annihilates that impression, by rousing him out of his waking dream, and unhappily restoring him to his senses. So difficult it is to support the impression of reality, that much slighter interruptions than the interval between two acts are sufficient to dissolve the charm: in the 5th act of the *Mourning Bride*, the three first scenes are in a room of state, the fourth in a prison; and the change is operated by shifting the scene, which is done in a trice: but however quick the transition may be, it is impracticable to impose upon the spectators so as to make them conceive that they are actually carried from the palace to the prison; they immediately reflect, that the palace and prison are imaginary, and that the whole is a fiction.

The three
Unities.
108
Whether
our drama
be preferable to
that of
Greece.

From these premises, one will naturally be led, at first view, to pronounce the frequent interruptions in the modern drama to be an imperfection. It will occur, "That every interruption must have the effect to banish the dream of reality, and with it to banish our concern, which cannot subsist while we are conscious that all is a fiction; and therefore, that in the modern drama, sufficient time is not afforded for fluctuation and swelling of passion, like what is afforded in that of Greece, where there is no interruption." This reasoning, it must be owned, has a specious appearance: but we must not become faint-hearted upon the first repulse; let us rally our troops for a second engagement.

On the Greek stage, whatever may have been the case on the Roman, the representation was never interrupted, and the division by acts was totally unknown. The word *act* never once occurs in Aristotle's *Poetics*, in which he defines exactly every part of the drama, and divides it into the beginning, the middle, and the end. At certain intervals indeed the actors retired; but the stage was not then left empty, nor the curtain let fall; for the chorus continued and sung. Neither do these songs of the chorus divide the Greek tragedies into five portions, similar to our acts; though some of the commentators have endeavoured to force them into this office. But it is plain, that the intervals at which the chorus sung are extremely unequal and irregular, suited to the occasion and the subject; and would divide the play sometimes into three, sometimes into seven or eight acts.

As practice has now established a different plan on the modern stage, has divided every play into five acts, and made a total pause in the representation at the end of each act, the question to be considered is, Whether the plan of the ancient or of the modern drama is best qualified for making a deep impression on the mind? That the preference is due to the plan of the modern drama, will be evident from the following considerations. If it be indeed true, as the advocates for the three unities allege, that the audience is deluded into the belief

The three
Unities.

of the reality of a well-acted tragedy, it is certain that this delusion cannot be long supported; for when the spirits are exhausted by close attention, and by the agitation of passion, an uneasiness ensues, which never fails to banish the waking dream. Now supposing the time that a man can employ with strict attention without wandering to be no greater than is requisite for a single act (a supposition that cannot be far from truth), it follows, that a continued representation of longer endurance than an act, instead of giving scope to fluctuation and swelling of passion, would overstrain the attention, and produce a total absence of mind. In this respect, the four pauses have a fine effect: for by affording to the audience a seasonable respite when the impression of reality is gone, and while nothing material is in agitation, they relieve the mind from its fatigue; and consequently prevent a wandering of thought at the very time possibly of the most interesting scenes.

In one article, indeed, the Grecian model has greatly the advantage: its chorus, during an interval, not only preserves alive the impressions made upon the audience, but also prepares their hearts finely for new impressions. In our theatres, on the contrary, the audience, at the end of every act, being left to trifle time away, lose every warm impression; and they begin the next act cool and unconcerned, as at the commencement of the representation. This is a gross malady in our theatrical representations; but a malady that luckily is not incurable: to revive the Grecian chorus, would be to revive the Grecian slavery of place and time; but we can figure a detached chorus coinciding with a pause in the representation, as the ancient chorus did with a pause in the principal action. What objection, for example, can there lie against music between the acts, vocal and instrumental, adapted to the subject? Such detached chorus, without putting us under any limitation of time or place, would recruit the spirits, and would preserve entire the tone, if not the tide, of passion: the music, after an act, should commence in the tone of the preceding passion, and be gradually varied till it accord with the tone of the passion that is to succeed in the next act. The music and the representation would both of them be gainers by their conjunction; which will thus appear. Music that accords with the present tone of mind, is, on that account, doubly agreeable; and accordingly, though music singly hath not power to raise a passion, it tends greatly to support a passion already raised. Further, music prepares us for the passion that follows, by making cheerful, tender, melancholy, or animated impressions, as the subject requires. Take for an example the first scene of the *Mourning Bride*, where soft music, in a melancholy strain, prepares us for Almeria's deep distress. In this manner, music and representation support each other delightfully: the impression made upon the audience by the representation, is a fine preparation for the music that succeeds; and the impression made by the music, is a fine preparation for the representation that succeeds. It appears evident, that by some such contrivance, the modern drama may be improved, so as to enjoy the advantage of the ancient chorus without its slavish limitation of place and time. But to return to the comparison between the ancient and the modern drama.

The numberless improprieties forced upon the Greek dramatic poets by the constitution of their drama, may

be sufficient, one should think, to make us prefer the modern drama, even abstracting from the improvement proposed. To prepare the reader for this article, it must be premised, that as in the ancient drama the place of action never varies, a place necessarily must be chosen to which every person may have access without any improbability. This confines the scene to some open place, generally the court or area before a palace; which excludes from the Grecian theatre transactions within doors, though these commonly are the most important. Such cruel restraint is of itself sufficient to cramp the most pregnant invention; and accordingly the Greek writers, in order to preserve unity of place, are reduced to woful improprieties. In the *Hippolytus* of Euripides (act 1. sc. 6.), Phedra, distressed in mind and body, is carried without any pretext from her palace to the place of action; is there laid upon a couch, unable to support herself upon her limbs; and made to utter many things improper to be heard by a number of women who form the chorus: and what is still more improper, her female attendant uses the strongest intreaties to make her reveal the secret cause of her anguish; which at last Phedra, contrary to decency and probability, is prevailed upon to do in presence of that very chorus (act 2. sc. 2.) Alceste, in Euripides, at the point of death, is brought from the palace to the place of action, groaning and lamenting her untimely fate (act 2. sc. 1.). In the *Trachiniae* of Sophocles (act. 2.), a secret is imparted to Dejanira, the wife of Hercules, in presence of the chorus. In the tragedy of *Iphigenia*, the messenger employed to inform Clytemnestra that Iphigenia was sacrificed, stops short at the place of action, and with a loud voice calls the queen from her palace to hear the news. Again, in the *Iphigenia in Tauris* (act 4.), the necessary presence of the chorus forces Euripides into a gross absurdity, which is to form a secret in their hearing; and, to disguise the absurdity, much court is paid to the chorus, not one woman but a number, to engage them to secrecy. In the *Medea* of Euripides, that princess makes no difficulty, in presence of the chorus, to plot the death of her husband, of his mistress, and of her father the king of Corinth, all by poison: it was necessary to bring Medea upon the stage; and there is but one place of action, which is always occupied by the chorus. This scene closes the second act; and in the end of the third, she frankly makes the chorus her confidants in plotting the murder of her own children. Terence, by identity of place, is often forced to make a conversation within doors be heard on the open street: the cries of a woman in labour are there heard distinctly.

The Greek poets are not less hampered by unity of time than by that of place. In the *Hippolytus* of Euripides, that prince is banished at the end of the 4th act; and in the first scene of the following act, a messenger relates to Theseus the whole particulars of the death of Hippolytus by the sea-monster: that remarkable event must have occupied many hours; and yet in the representation it is confined to the time employed by the chorus upon the song at the end of the 4th act. The inconsistency is still greater in the *Iphigenia in Tauris* (act 5. sc. 4.): the song could not exhaust half an hour; and yet the incidents supposed to have happened during that time could not naturally have been transacted in less than half a day.

The

109
An improvement
of the modern drama
suggested
Elem. of
Criticism,
ch. 23.

The three
Unities.

110
The modern drama
pre-ferable to
the ancient.

111
Inconveniences of
the plan
of the ancient drama.

The three
Unities.

The Greek artists are forced, not less frequently, to transgress another rule, derived also from a continued representation. The rule is, that as a vacuity, however momentary, interrupts the representation, it is necessary that the place of action be constantly occupied. Sophocles, with regard to that rule as well as to others, is generally correct: but Euripides cannot bear such restraint; he often evacuates the stage, and leaves it empty for others. Iphigenia in Tauris, after pronouncing a soliloquy in the first scene, leaves the place of action, and is succeeded by Orestes and Pylades: they, after some conversation, walk off; and Iphigenia re-enters, accompanied with the chorus. In the Alcestes, which is of the same author, the place of action is void at the end of the third act. It is true, that to cover the irregularity, and to preserve the representation in motion, Euripides is careful to fill the stage without loss of time: but this still is an interruption, and a link of the chain broken: for during the change of the actors, there must be a space of time, during which the stage is occupied by neither set. It makes indeed a more remarkable interruption, to change the place of action as well as the actors; but that was not practicable upon the Grecian stage.

It is hard to say upon what model Terence has formed his plays. Having no chorus, there is a pause in the representation at the end of every act: but advantage is not taken of the cessation, even to vary the place of action; for the street is always chosen, where every thing passing may be seen by every person; and by that choice, the most sprightly and interesting parts of the action, which commonly pass within doors, are excluded; witness the last act of the *Eunuch*. He hath submitted to the like slavery with respect to time. In a word, a play with a regular chorus, is not more confined in place and time than his plays are. Thus a zealous sectary follows implicitly ancient forms and ceremonies, without once considering whether their inductive cause be still subsisting. Plautus, of a bolder genius than Terence, makes good use of the liberty afforded by an interrupted representation: he varies the place of action upon all occasions, when the variation suits his purpose.

Elem. of
Criticism,
ch. 23.

112
No change
of time or
place to
be admit-
ted but be-
tween the
acts.

The intelligent reader will by this time understand, that we plead for no change of place in our plays but after an interval, nor for any latitude in point of time but what falls in with an interval. The unities of place and time ought to be strictly observed during each act; for during the representation there is no opportunity for the smallest deviation from either. Hence it is an essential requisite, that during an act the stage be always occupied; for even a momentary vacuity makes an interval or interruption. Another rule is no less essential: it would be a gross breach of the unity of action to exhibit upon the stage two separate actions at the same time; and therefore, to preserve that unity, it is necessary that each personage introduced during an act be linked to those in possession of the stage, so as to join all in one action. These things follow from the very conception of an act, which admits not the slightest interruption: the moment the representation is intermitted, there is an end of that act; and we have no other notion of a new act, but where, after a pause or interval, the representation is again put in motion. French writers,

generally speaking, are correct in this particular. The English, on the contrary, are so irregular as scarce to deserve a criticism: actors not only succeed each other in the same place without connection, but, what is still less excusable, they frequently succeed each other in different places. This change of place in the same act ought never to be indulged; for, beside breaking the unity of the act, it has a disagreeable effect: after an interval, the imagination adapts itself to any place that is necessary, as readily as at the commencement of the play; but during the representation we reject change of place. From the foregoing censure must be excepted the *Mourning Bride* of Congreve, where regularity concurs with the beauty of sentiment and of language, to make it one of the most complete pieces England has to boast of. It is to be acknowledged, however, that in point of regularity this elegant performance is not altogether unexceptionable. In the four first acts, the unities of place and time are strictly observed: but in the last act, there is a capital error with respect to unity of place; for in the three first scenes of that act, the place of action is a room of state, which is changed to a prison in the fourth scene: the chain also of the actors is broken; as the persons introduced in the prison are different from those who made their appearance in the room of state. This remarkable interruption of the representation makes in effect two acts instead of one: and therefore, if it be a rule that a play ought not to consist of more acts than five, this performance is so far defective in point of regularity. It may be added, that, even admitting six acts, the irregularity would not be altogether removed, without a longer pause in the representation than is allowed in the acting; for more than a momentary interruption is requisite for enabling the imagination readily to fall in with a new place, or with a wide space of time. In *The Way of the World*, of the same author, unity of place is preserved during every act, and a stricter unity of time during the whole play than is necessary.

§ 4. Of the Opera.

An opera is a drama represented by music. This The opera, 113
entertainment was invented at Venice. An exhibi-a drama re-
tion of this sort requires a most brilliant magnificence, presented
and an expence truly royal. The drama must neces- by music,
sarily be composed in verse; for as operas are sung
and accompanied with symphonies, they must be in
verse to be properly applicable to music. To render
this entertainment still more brilliant, it is ornamented
with dances and ballettes, with superb decorations,
and surprising machinery. The dresses of the actors,
of those who assist in the chorus, and of the dancers,
being all in the most splendid and elegant taste, contri-
bute to render the exhibition highly sumptuous. But
notwithstanding this union of arts and pleasures at
an immense expence, and notwithstanding a most daz-
zling pageantry, an opera appears, in the eyes of
many people of taste, but as a magnificent absurdity,
seeing that nature is never there from the beginning to
the end. It is not our business here, however, to de-
termine between the different tastes of mankind.

The method of expressing our thoughts by singing
and music is so little natural, and has something in it
so forced and affected, that it is not easy to conceive
how

Bielfeld's
Elem. of
Erudition.

114
Should take
its subject
not from
history but
from fable
and en-
chantment,

how it could come into the minds of men of genius to represent any human action, and, what is more, a serious or tragic action, any otherwise than by speech. We have, it is true, operas in English by Addison, &c. in Italian by Metastasio, in French by M. Quinault, Fontenelle, &c. the subjects of which are so grave and tragic, that one might call them musical tragedies, and real *chefs d'œuvres* in their kind. But though we are highly satisfied and greatly affected on reading them, and are much pleased with seeing them represented, yet the spectator is, perhaps, more charmed with the magnificence of the sight and the beauty of the music, than moved with the action and the tragical part of the performance. We are not, however, of that order of critics who strive to prove, that mankind act wrong in finding pleasure in an object with which they are really pleased; who blame a lover for thinking his mistress charming, when her features are by no means regular; and who are perpetually applying the rules of logic to the works of genius: we make these observations merely in order to examine if it be not possible to augment the pleasures of a polite people, by making the opera something more natural, more probable, and more consonant to reason.

We think, therefore, that the poet should never, or at least very rarely, choose a subject from history, but from fable or mythology, or from the regions of enchantment. Every rational mind is constantly shocked to hear a mutilated hero trill out, from the slender pipe of a chaffinch, *To arms! To arms!* and in the same tone animate his soldiers, and lead them to the assault; or harangue an assembly of grave senators, and sometimes a whole body of people. Nothing can be more burlesque than such exhibitions; and a man must be possessed of a very uncommon sensibility to be affected by them. But as we know not what was the language of the gods, and their manner of expressing themselves, we are at liberty in that case to form what illusions we please, and to suppose that they sung to distinguish themselves from mortals. Besides, all the magic of decorations and machinery become natural, and even necessary, in these kinds of subjects; and therefore readily afford opportunity for all the pomp of these performances. The chorus, the dances, the ballettes, the symphonies and dresses, may likewise be all made to correspond with such subjects: nothing is here affected, absurd, or unnatural. Whoever is possessed of genius, and is well acquainted with mythology, will there find an inexhaustible source of subjects highly diversified, and quite proper for the drama of an opera.

We shall not speak here of that sort of music which appears to us the most proper for such a drama, and of the several alterations of which we think it susceptible, in order to make it more complete, and to adapt it to a more pathetic, more noble, and more natural expression, as well in the recitatives as in the airs and chorus. (See Music). We have only here to consider the business of the poet. He should never lose sight of nature, even in the midst of the greatest fiction. A god, a demi-god, a renowned hero, such for example as Renaud in *Armida*, a fairy, a genie, a nymph, or fury, &c. should constantly be represented according to the characters we give them, and never be made to talk the language of a fop or a *petite maitresse*. The

recitative, which is the ground-work of the dialogue, requires verses that are free and not regular, such as with a simple cadence approach the nearest to common language. The airs should not be forced into the piece, nor improperly placed for the sake of terminating a scene, or to display the voice of a performer: they should express some sentiment, or some precept, short and striking, or tender and affecting; or some simile lively and natural; and they should arise of themselves from a monologue, or from a scene between two persons: prolixity should here be particularly avoided, especially when such an air makes part of a dialogue; for nothing is more insipid or disgusting than the countenances of the other actors who appear at the same time, whose silence is quite unmeaning, and who know not what to do with their hands and feet while the singer is straining his throat. The verse of all the airs should be of the lyric kind, and should contain some poetic image, or paint some noble passion, which may furnish the composer with an opportunity of displaying his talents, and of giving a lively and affecting expression to the music. A phrase that is inanimated can never have a good effect in the performance, but must become insipid and horribly tedious in the air. The trite similes of the Italians, of a stream that flows, or a bird that flies, &c. are no longer sufferable. The same thing may be said with regard to the chorus, which should be equally natural and well adapted: it is here sometimes a whole people, sometimes the inhabitants of a peculiar country, and sometimes warriors, nymphs, or priests, &c. who raise their voice to demand justice, to implore favour, or render a general homage. The action itself will furnish the poet of genius with ideas, words, and the manner of disposing them.

Lastly, the opera being a performance calculated less to satisfy the understanding than to charm the ear and affect the heart, and especially to strike the sight, the poet should have a particular attention to that object, should be skilled in the arts of a theatre, should know how to introduce combats, ballettes, feasts, games, pompous entries, solemn processions, and such marvellous incidents as occur in the heavens, upon earth, in the sea, and even in the infernal regions: but all these matters demand a strong character, and the utmost precision in the execution: for otherwise, the comic being a near neighbour to the sublime, they will easily become ridiculous. The unity of action must certainly be observed in such a poem, and all the incidental episodes must concur to the principal design; otherwise it would be a monstrous chaos. It is impossible, however, scrupulously to observe the unity of time and place: though the liberty, which reason allows the poet in this respect, is not without bounds; and the less use he makes of it, the more perfect his poem will be. It is not perhaps impossible so to arrange the objects, that, in changing the decorations, the painter may constantly make appear some part of the principal decoration which characterises the situation of the scene, as the corner of a palace, at the end of a garden, or some avenue that leads to it, &c. But all this is liable to difficulties, and even to exceptions; and the art of the painter must concur in such case with that of the poet. For the rest, all the operas of Europe are at least one third too long; especially the Italian. The unity of action requires brevity; and satiety is inseparable from a di-

version

115
And should
represent
its charac-
ters as con-
sistent.

116
Unity of
action ne-
cessary to
the opera.

Of Lyric
Poetry.

version that lasts full four hours, and sometimes longer.

They have indeed endeavoured to obviate this inconvenience by dividing an opera into three, and even into five acts; but experience proves, that this division, though judicious, is still not sufficient to relieve the wearied attention.

SECT. II. *Of Lyric Poetry.*117
Origin of
the ode.

THE ode is very ancient, and was probably the first species of poetry. It had its source, we may suppose, from the heart, and was employed to express, with becoming fervour and dignity, the grateful sense man entertained of the blessings which daily flowed from God the fountain of all goodness: hence their harvest hymns, and other devotional compositions of that kind.

But in process of time it was employed, not only to praise the Almighty for bounties received, but to solicit his aid in time of trouble; as is plain from the odes written by king David and others, and collected by the Jewish Sanhedrim into the book of Psalms, to be sung at their fasts, festivals, and on other solemn occasions. Nor was this practice confined to the Israelites only: other nations had their songs of praise and petitions of this sort, which they preferred to their deities in time of public prosperity and public distress, as well as to those heroes who distinguished themselves in arms. Even the American Indians, whose notions of religion are extremely confined, have their war-songs, which they sing to this day.

It is reasonable to suppose that the awful purpose to which the ode was applied, gave rise among the ancients to the custom of invoking the muses; and that the poets, in order to raise their sentiments and language, so as to be acceptable to their deities, thought it expedient to solicit some divine assistance. Hence poets are said to have been inspired, and hence an unbounded liberty has been given to the ode; for the lyric poet, fired, as it were, with his subject, and borne away on the wings of gratitude, disdains grammatical niceties and common modes of speech, and often soars above rule, though not above reason. This freedom, however, consists chiefly in sudden transitions, bold digressions, and lofty excursions. For the ancient poets, and even Pindar, the most daring and lofty of them all, has in his sublimest flights, and amidst all his rapture, preserved harmony, and often uniformity in his versification: but so great is the variety of his measures, that the traces of sameness are in a manner lost; and this is one of the excellencies for which that poet is admired, and which, though seemingly devoid of art, requires so much that he has seldom been imitated with success.

The ancients in their odes indulged such a liberty of fancy, that some of their best poets not only make bold excursions and digressions, but, having in their flights started some new and noble thought, they frequently pursue it, and never more return to their subject. But this loose kind of ode, which seems to reject all method, and in which the poet, having just touched upon his subject, immediately diverts to another, we should think blameable, were it lawful to call in question the authority of those great men who were our preceptors in this

art. We may venture to affirm, however, that these compositions stand in no degree of comparison with other odes of theirs; in which, after wandering from the subject in pursuit of new ideas arising from some of its adjuncts, and ranging wantonly, as it were, through a variety of matter, the poet is from some other circumstance led naturally to his subject again; and, like a bee, having collected the essence of many different flowers, returns home, and unites them all in one uniform pleasing sweet.

The ode among the ancients signified no more than a The sub-song: but with the moderns, the ode and the song are subjects of the considered as different compositions; the ode being usually employed in grave and lofty subjects, and seldom sung but on solemn occasions.

The subjects most proper for the ode and song, Horace has pointed out in a few elegant lines.

Gods, heroes, conquerors, *Olympic* crowns,
Love's pleasing cares, and the free joys of wine,
Are proper subjects for the lyric song.

To which we may add, that happiness, the pleasures of a rural life, and such parts of morality as afford lessons for the promotion of our felicity, and reflections on the conduct of life, are equally suitable to the ode. This both *Pindar* and *Horace* were so sensible of, that many of their odes are seasoned with these moral sentences and reflections.

But who can number ev'ry sandy grain
Wash'd by *Sicilia's* hoarse-resounding main?
Or who can *Theron's* gen'rous works express,
And tell how many hearts his bounteous virtues bless?
Ode to THERON.

And in another *Olympic* ode, inscribed by the same poet to *Diagoras* of *Rhodes* (and in such esteem, that it was deposited in the temple of *Minerva*, written in letters of gold), *Pindar*, after exalting them to the skies, concludes with this lesson in life:

Yet as the gales of fortune various blow,
To-day tempestuous, and to-morrow fair,
Due bounds, ye *Rhodians*, let your transports know;
Perhaps to-morrow comes a storm of care.
WEST'S PINDAR.

The man resolv'd and steady to his trust,
Inflexible to ill, and obstinately just,
May the rude rabble's insolence despise,
Their senseless clamours and tumultuous cries;
The tyrant's fierceness he beguiles,
And the stern brow and the harsh voice defies,
And with superior greatness smiles.

Not the rough whirlwind, that deforms
Adria's black gulph, and vexes it with storms,
The stubborn virtue of his soul can move;
Nor the red arm of angry *Jove*,
That flings the thunder from the sky,
And gives it rage to roar, and strength to fly.
Should the whole frame of nature round him break,
In ruin and confusion hurl'd,
He unconcern'd would hear the mighty crack,
And stand secure amidst a falling world.

HORACE.

M.

M. Despreaux has given us a very beautiful and just description of the ode in these lines.

L'Ode avec plus d'éclat, & non moins d'énergie
Elevant jusqu'au ciel son vol ambitieux,
Entretient dans vers commerce avec les Dieux.
Aux Athletes dans Pise elle ouvre la barrière,
Chante un vainqueur poudreux au bout de la carrière;
Mène Achille sanglant au bords du Simois
Ou fait flechir l'Eseaut sous le joug de Louis.
Tantôt comme une abeille ardente à son ouvrage
Elle s'en va de fleurs dépouiller le rivage :
Elle peint les festins, les danses & les ris,
Vante un baïser cueilli sur les levres d'Iris,
Qui mollement résiste & par un doux caprice
Quelquefois le refuse, afin qu'on le ravisse.
Son style impetueux souvent marche au hasard.
Chez elle un beau desordre est un effet de l'art,
Loin ces rimeurs craintifs, dont l'esprit plegmatique
Garde dans ses fureurs un ordre didactique :
Qui chantant d'un heros les progrès éclatans,
Maigres historiens, suivront l'ordre des temps.
Apollon de son feu leur fut toujours avare, &c.

The lofty ode demands the strongest fire,
For there the muse all Phœbus must inspire :
Mounting to heav'n in her ambitious flight,
Amongst the gods and heroes takes delight ;
Of Pisa's wrestlers tells the sinewy force,
And sings the dusty conqueror's glorious course ;
To Simois' banks now fierce Achilles sends,
Beneath the Gallic yoke now Eseaut bends :
Sometimes she flies, like an industrious bee,
And robs the flow'rs by nature's chemistry ;
Describes the shepherds dances, feasts, and bliss,
And boasts from Phillis to surprise a kiss,
When gently she resists with feign'd remorse,
That what she grants may seem to be by force.
Her generous style will oft at random start,
And by a brave disorder show her art ;
Unlike those fearful poets whose cold rhyme
In all their raptures keeps exactest time,
Who sing the illustrious hero's mighty praise,
Dry journalists, by terms of weeks and days ;
To these, Apollo, thrifty of his fire,
Denies a place in the Pierian choir, &c.

SOAMES.

The variety of subjects, which are allowed the lyric poet, makes it necessary to consider this species of poetry under the following heads, viz. the *sublime* ode, the *lesser* ode, and the *song*. We shall begin with the lowest, and proceed to that which is more eminent.

120
The song.

I. *Songs* are little poetical compositions, usually set to a tune, and frequently sung in company by way of entertainment and diversion. Of these we have in our language a great number ; but, considering that number, not many which are excellent ; for, as the Duke of Buckingham observes,

Though nothing seems more easy, yet no part
Of poetry requires a nicer art.

The song admits of almost any subject ; but the greatest part of them turn either upon *love*, *contentment*, or the *pleasures* of a *country life*, and *drinking*. Be the subject, however, what it will, the verses should be easy,

natural, and flowing, and contain a certain harmony, so that poetry and music may be agreeably united. In these compositions, as in all others, obscene and profane expressions should be carefully avoided, and indeed every thing that tends to take off that respect which is due to religion and virtue, and to encourage vice and immorality. As the best songs in our language are already in every hand, it would seem superfluous to insert examples. For further precepts, however, as well as select examples, in this species of composition, we may refer the reader to the elegant *Essay on Song Writing*, by Mr Aikin.

II. The *lesser ode*. The distinguishing character of this is sweetness ; and as the pleasure we receive from this sort of poem arises principally from its soothing and affecting the passions, great regard should be paid to the language as well as to the thoughts and numbers.

121
The distinguishing character of the lesser ode.

Th' expression should be easy, fancy high ;
Yet that not seem to creep, nor this to fly :
No words transpos'd, but in such order all,
As, though hard wrought, may seem by chance to fall.

D. Buckingham's *Essay*.

The style, indeed, should be easy : but it may be also florid and figurative. It solicits delicacy, but disdains affectation. The thoughts should be natural, chaste, and elegant ; and the numbers various, smooth, and harmonious. A few examples will sufficiently explain what we mean.

Longinus has preserved a fragment of Sappho, an ancient Greek poetess, which is in great reputation amongst the critics, and has been so happily translated by Mr Phillips as to give the English reader a just idea of the spirit, ease, and elegance of that admired author ; and show how exactly she copied nature. To enter into the beauties of this ode, we must suppose a lover sitting by his mistress, and thus expressing his passion :

Blest as th' immortal gods is he,
The youth who fondly sits by thee,
And sees and hears thee all the while
Softly speak, and sweetly smile.
'Twas this depriv'd my soul of rest,
And rais'd such tumults in my breast ;
For while I gaz'd, in transport tost,
My breath was gone, my voice was lost.
My bosom glow'd, the subtle flame
Ran quick through all my vital frame :
O'er my dim eyes a darkness hung ;
My ears with hollow murmurs rung.
In dewy damps my limbs were chill'd ;
My blood with gentle horrors thrill'd ;
My feeble pulse forgot to play ;
I fainted, sunk, and dy'd away.

122
The Sapphic ode.

After this instance of the Sapphic ode, it may not be improper to speak of that sort of ode which is called *Anacreontic* ; being written in the manner and taste of Anacreon, a Greek poet, famous for the delicacy of his wit, and the exquisite, yet easy and natural, turn of his poetry. We have several of his odes still extant, and many modern ones in imitation of him, which are mostly composed in verses of seven syllables, or three feet and a half.

We shall give the young student one or two examples of his manner from Mr Fawkes's excellent translation.

123
The Anacreontic ode.

The following ode on the power of gold, which had been often attempted but with little success, this gentleman has translated very happily.

Love's a pain that works our woe;
Not to love is painful too:
But, alas! the greatest pain
Waits the love that meets disdain.

What avails ingenuous worth,
Sprightly wit, or noble birth?
All these virtues useless prove;
Gold alone engages love.

May he be completely curst,
Who the sleeping mischief first
Wak'd to life, and, vile before,
Stamp'd with worth the sordid ore.
Gold creates in brethren strife;
Gold destroys the parent's life;
Gold produces civil jars,
Murders, massacres, and wars;
But the worst effect of gold,
Love, alas! is bought and sold.

His ode on the vanity of riches is of a piece with the above, and conveys a good lesson to those who are over anxious for wealth.

If the treasur'd gold could give
Man a longer term to live,
I'd employ my utmost care
Still to keep, and still to spare;
And, when death approach'd, would say,
'Take thy fee, and walk away.'

But since riches cannot save
Mortals from the gloomy grave,
Why should I myself deceive,
Vainly sigh, and vainly grieve?
Death will surely be my lot,
Whether I am rich or not.

Give me freely while I live
Generous wines, in plenty give
Soothing joys my life to cheer,
Beauty kind, and friends sincere;
Happy! could I ever find
Friends sincere, and beauty kind.

But two of the most admired, and perhaps the most imitated, of Anacreon's odes, are that of Mars wounded by one of the darts of Love, and Cupid stung by a Bee; both which are wrought up with fancy and delicacy, and are translated with elegance and spirit.—
Take that of Cupid stung by a bee.

Once as Cupid, tir'd with play,
On a bed of roses lay,
A rude bee, that slept unseem,
The sweet breathing buds between,
Stung his finger, cruel chance!
With its little pointed lance.
Straight he fills the air with cries,
Weeps, and sobs, and runs, and flies;
'Till the god to Venus came,
Lovely, laughter-loving dame:
Then he thus began to plain;
"Oh! undone—I die with pain——"
"Dear mamma, a serpent small,
"Which a bee the ploughmen call,

Vol. XV. Part I.

"Imp'd with wings, and arm'd with dart,
"Oh!—has stung me to the heart."
Venus thus reply'd, and smil'd:
'Dry those tears for shame! my child;
'If a bee can wound so deep,
'Causing Cupid thus to weep,
'Think, O think! what cruel pains
'He that's stung by thee sustains.'

Among the most successful of this poet's English imitations may be reckoned Dr Johnson and Mr Prior. The following ode on *Evening* by the former of these writers has, if we mistake not, the very spirit and air of Anacreon.

Evening now from purple wings
Sheds the grateful gifts she brings;
Brilliant drops bedeck the mead;
Cooling breezes shake the reed;
Shake the reed, and curl the stream
Silver'd o'er with Cynthia's beam;
Near the chequer'd lonely grove
Hears, and keeps thy secrets, Love.
Stella, thither let us stray!
Lightly o'er the dewy way.
Phœbus drives his burning car
Hence, my lovely Stella, far:
In his stead the queen of night
Round us pours a lambent light;
Light that seems but just to show
Breasts that beat, and cheeks that glow:
Let us now, in whisper'd joy,
Evening's silent hours employ;
Silence best, and conscious shades,
Please the hearts that love invades:
Other pleasures give them pain;
Lovers all but love disdain.

But of all the imitations of the playful bard of Greece that we have ever met with, the most perfect is the following Anacreontic by the regent Duke of Orleans.

I.

Je suis né pour les plaisirs;
Bien fou qui s'en passe:
Je ne veux pas les choisir;
Souvent le choix m'embarrasse:
Aime t'on? J'aime soudain;
Bois t'on? J'ai le verre à la main;
Je tiens par tout ma place.

II.

Dormir est un temps perdu;
Faut il qu'on s'y livre?
Sommeil, prends ce qui t'est dû;
Mais attends que je sois yvre:
Saisis moi dans cet instant;
Fais moi dormir promptement;
Je suis pressé de vivre.

III.

Mais si quelque objet charmant,
Dans un songe aimable,
Vient d'un plaisir séduisant
M'offrir l'image agréable;
Sommeil, allons doucement;
L'erreur est en ce moment
Un bonheur véritable.

E c

Translations

Translation of the Regent's Anacreontic (E).

Frolic and free, for pleasure born,
The self-denying fool I scorn :
The proffer'd joy I ne'er refuse ;
'Tis oft-times troublesome to chuse.
Lov'st thou, my friend? I love at sight :
Drink'lt thou? this bumper does thee right.
At random with the stream I flow,
And play my part where'er I go.

Great God of Sleep, since we must be
Oblig'd to give some hours to thee,
Invade me not till the full bowl
Glows in my cheek, and warms my soul.
Be *that* the only time to snore,
When I can love and drink no more :
Short, very short, then be thy reign ;
For I'm in haste to live again.

But, O ! if melting in my arms,
In some soft dream, with all her charms,
The nymph below'd should then surprise,
And grant what waking she denies ;
Then prithee, gentle Slumber, stay ;
Slowly, ah slowly, bring the day :
Let no rude noise my bliss destroy ;
Such sweet delusion's real joy.

125
Sappho.

We have mentioned Prior as an imitator of Anacreon ; but the reader has by this time had a sufficient specimen of Anacreontics. The following *Answer to Cloe jealous*, which was written when Prior was sick, has much of the elegant tenderness of Sappho.

Yes, fairest proof of beauty's pow'r,
Dear idol of my panting heart,
Nature points this my fatal hour :
And I have liv'd : and we must part.
While now I take my last adieu,
Heave thou no sigh, nor shed a tear ;
Left yet my half-clos'd eye may view
On earth an object worth its care.
From jealousy's tormenting strife
For ever be thy bosom freed ;
That nothing may disturb thy life,
Content I hasten to the dead.
Yet when some better-fated youth
Shall with his am'rous parly move thee,
Reflect one moment on his truth
Who, dying, thus persists to love thee.

There is much of the softness of Sappho, and the sweetness of Anacreon and Prior, in the following ode, which is ascribed to the late unfortunate Dr Dodd ; and was written in compliment to a lady, who, being sick, had sent the author a moss rose-bud, instead of making his family a visit. This piece is particularly to be esteemed for the just and striking moral with which it is pointed.

The slightest of favours bestow'd by the fair,
With rapture we take, and with triumph we wear :

But a moss-woven rose-bud, Eliza, from thee,
A well-pleasing gift to a monarch would be.
—Ah ! that illness, too cruel, forbidding should stand,
And refuse me the gift from thy own lovely hand !
With joy I receive it, with pleasure will view,
Reminded of thee, by its odour and hue :
“ Sweet rose, let me tell thee, tho' charming thy bloom,
Tho' thy fragrance excels Seba's richest perfume ;
Thy breath to Eliza's no fragrance hath in't,
And but dull is thy bloom to her cheek's blushing tint.
Yet, alas ! my fair flow'r, that bloom will decay,
And all thy lov'd beauties soon wither away ;
Tho' pluck'd by her hand, to whose touch, we must own,
Harsh and rough is the cygnet's most delicate down :”
Thou too, snowy hand ; nay, I mean not to preach ;
But the rose, lovely moralist, suffer to teach.
“ Extol not, fair maiden, thy beauties o'er mine ;
They too are short-liv'd, and they too must decline ;
And small, in conclusion, the difference appears,
In the bloom of few days, or the bloom of few years !
But remember a virtue the rose hath to boast,
—Its fragrance remains when its beauties are lost !”

We come now to those odes of the more florid and figurative kind, of which we have many in our language that deserve particular commendation. Mr Warton's Ode to Fancy has been justly admired by the best judges ; for though it has a distant resemblance of Milton's *L'Allegro* and *Il Penseroso*, yet the work is original ; the thoughts are mostly new and various, and the language and numbers elegant, expressive, and harmonious.

126
Odes more
florid and
figurative.

O parent of each lovely muse,
Thy spirit o'er my soul diffuse !
O'er all my artless songs preside,
My footsteps to thy temple guide !
To offer at thy turf-built shrine
In golden cups no costly wine,
No murder'd fatling of the flock,
But flow'rs and honey from the rock.
O nymph, with loosely flowing hair,
With buskin'd leg, and bosom bare ;
Thy wait with myrtle-girdle bound,
Thy brows with Indian feathers crown'd ;
Waving in thy snowy hand
An all-commanding magic wand,
Of pow'r to bid fresh gardens blow
'Mid cheerless Lapland's barren snow :
Whose rapid wings thy flight convey,
Through air, and over earth and sea ;
While the vast various landscape lies
Conspicuous to thy piercing eyes.
O lover of the desert, hail !
Say, in what deep and pathless vale,
Or on what hoary mountain's side,
'Midst falls of water, you reside ;
'Midst broken rocks, a rugged scene,
With green and grassy dales between ;
'Midst forests dark of aged oak,
Ne'er echoing with the woodman's stroke ;

Where

(E) We give this translation, both because of its excellence and because it is said to have been the production of no less a man than the late Lord Chatham.

Where never human art appear'd,
Nor ev'n one straw-roof'd cott was rear'd ;
Where Nature seems to sit alone,
Majestic on a craggy throne.
Tell me the path, sweet wand'rer ! tell,
To thy unknown sequester'd cell,
Where woodbines cluster round the door,
Where shells and moss o'erlay the floor,
And on whose top an hawthorn blows,
Amid whose thickly-woven boughs
Some nightingale still builds her nest,
Each ev'ning warbling thee to rest.
Then lay me by the haunted stream,
Wrapt in some wild poetic dream ;
In converse while methinks I rove
With Spenser through a fairy grove ;
Till suddenly awak'd, I hear
Strange whisper'd music in my ear ;
And my glad soul in bliss is drown'd
By the sweetly soothing sound !
Me, goddess, by the right-hand lead,
Sometimes through the yellow mead ;
Where Joy and white-rob'd Peace resort,
And Venus keeps her festive court ;
Where Mirth and Youth each ev'ning meet,
And lightly trip with nimble feet,
Nodding their lily-crowned heads,
Where Laughter rose-lip'd Hebe leads ;
Where Echo walks steep hills among,
Lift'ning to the shepherd's song.
Yet not these flow'ry fields of joy
Can long my pensive mind employ ;
Haste, Fancy, from the scenes of Folly,
To meet the matron Melancholy !
Goddess of the tearful eye,
That loves to fold her arms and sigh.
Let us with silent footsteps go
To charnels, and the house of wo ;
To Gothic churches, vaults, and tombs,
Where each sad night some virgin comes,
With throbbing breast and faded cheek,
Her promis'd bridegroom's urn to seek :
Or to some abbey's mould'ring tow'rs,
Where, to avoid cold wint'ry show'rs,
The naked beggar shivering lies,
While whistling tempests round her rise,
And trembles lest the tott'ring wall
Should on her sleeping infants fall.

Now let us louder strike the lyre,
For my heart glows with martial fire ;
I feel, I feel, with sudden heat,
My big tumultuous bosom beat ;
The trumpet's clangors pierce my ear,
A thousand widows shrieks I hear :
Give me another horse, I cry ;
Lo, the base Gallic squadrons fly !
Whence is this rage ?—what spirit, say,
To battle hurries me away ?
'Tis Fancy, in her fiery car,
Transports me to the thickest war ;
There whirls me o'er the hills of slain,
Where tumult and destruction reign ;
Where, mad with pain, the wounded steed,
Tramples the dying and the dead ;

Where giant Terror stalks around,
With fullen joy surveys the ground,
And, pointing to th' ensanguin'd field,
Shakes his dreadful gorgon shield !
O guide me from this horrid scene
To high-arch'd walks and alleys green,
Which lovely Laura seeks, to shun
The fervors of the mid-day sun.
The pangs of absence, O remove,
For thou can'st place me near my love ;
Can'st fold in visionary bliss,
And let me think I steal a kiss ;
While her ruby lips dispense
Luscious nectar's quintessence !
When young-ey'd Spring profusely throws
From her green lap the pink and rose ;
When the soft turtle of the dale
To Summer tells her tender tale ;
When Autumn cooling caverns seeks,
And stains with wine his jolly cheeks ;
When Winter, like poor pilgrim old,
Shakes his silver beard with cold ;
At ev'ry season let my ear
Thy solemn whispers, Fancy, hear.
O warm enthusiastic maid !
Without thy powerful, vital aid,
That breathes an energy divine,
That gives a soul to ev'ry line,
Ne'er may I strive with lips profane,
To utter an unhallow'd strain ;
Nor dare to touch the sacred string,
Save when with smiles thou bid'st me sing.
O hear our pray'r, O hither come
From thy lamented Shakespeare's tomb,
On which thou lov'st to sit at eve,
Musing o'er thy darling's grave.
O queen of numbers, once again
Animate some chosen swain,
Who, fill'd with unexhausted fire,
May boldly smite the sounding lyre ;
Who with some new, unequal'd song,
May rise above the rhyming throng ;
O'er all our list'ning passions reign,
O'erwhelm our souls with joy and pain ;
With terror shake, with pity move,
Rouse with revenge, or melt with love.
O deign t'attend his evening walk,
With him in groves and grottoes talk ;
Teach him to scorn, with frigid art,
Feebly to touch th' enraptur'd heart ;
Like lightning, let his mighty verse
The bosom's inmost foldings pierce ;
With native beauties win applause,
Beyond cold critics studied laws :
O let each muse's fame increase !
O bid Britannia rival Greece !

The following ode, written by Mr Smart on the 5th of December (being the birth-day of a beautiful young lady), is much to be admired for the variety and harmony of the numbers, as well as for the beauty of the thoughts, and the elegance and delicacy of the compliment. It has great fire, and yet great sweetness, and is the happy issue of genius and judgment united.

Hail eldest of the monthly train,
Sire of the winter drear,
December! in whose iron reign
Expires the chequer'd year.
Hush all the blust'ring blasts that blow,
And proudly plum'd in silver snow,
Smile gladly on this blest of days;
The livery'd clouds shall on thee wait,
And Phœbus shine in all his state
With more than summer rays.
Though jocund June may justly boast
Long days and happy hours;
Though August be Pomona's host;
And May be crown'd with flow'rs:
Tell June his fire and crimson dies,
By Harriot's blush, and Harriot's eyes,
Eclips'd and vanquish'd, fade away;
Tell August, thou canst let him see
A richer, riper fruit than he,
A sweeter flow'r than May.

¹²⁷
A pastoral
and elegiac
ode. The ensuing ode, written by Mr Collins on the death
of Mr Thomson, is of the pastoral and elegiac kind, and
both picturesque and pathetic. To perceive all the beau-
ties of this little piece, which are indeed many, we must
suppose them to have been delivered on the river Thames
near Richmond.

* The harp
of Æolus.

In yonder grave a Druid lies,
Where slowly winds the stealing wave;
The year's best sweets shall duteous rise
To deck its poet's silvan grave!
In yon deep bed of whisp'ring reeds
His airy harp * shall now be laid,
That he, whose heart in sorrow bleeds,
May love through hie the soothing shade.
Then maids and youths shall linger here,
And, while its sounds at distance swell,
Shall sadly seem in pity's ear
To hear the woodland pilgrim's knell.
Remembrance oft shall haunt the shore,
When Thames in summer wreaths is drest,
And oft suspend the dashing oar,
To bid his gentle spirit rest!
And oft as ease and health retire
To breezy lawn, or forest deep,
The friend shall view yon whitening spire †,
And 'mid the varied landscape weep.
But thou, who own'st that earthy bed,
Ah! what will ev'ry dirge avail?
Or tears, which love and pity shed,
That mourn beneath the gliding sail?
Yet lives there one, whose heedless eye,
Shall scorn thy pale shining glimm'ring near ‡
With him, sweet bard, may fancy die,
And joy-desert the blooming year.
But thou, lorn stream, whose sullen tide
No sedge-crown'd sisters now attend,
Now waft me from the green hill's side,
Whose cold turf hides the buried friend.
And see, the fairy valleys fade,
Dim night has veil'd the solemn view!
Yet once again, dear parted shade,
Meek nature's child, again adieu!
The genial meads, assign'd to blefs
Thy life, shall mourn thy early doom;

† Rich-
mond-
church.

Their hinds, and shepherd girls, shall dress,
With simple hands, thy rural tomb.
Long, long, thy stone and pointed clay
Shall melt the musing Briton's eyes;
O vales and wild woods, shall he say,
In yonder grave your Druid lies!

¹²⁸
The hymn. Under this species of the ode, notice ought to be
taken of those written on divine subjects, and which are
usually called *hymns*. Of these we have many in our
language, but none perhaps that are so much admired
as Mr Addison's. The beauties of the following hymn
are too well known, and too obvious, to need any com-
mendation; we shall only observe, therefore, that in
this hymn (intended to display the power of the Al-
mighty) he seems to have had a psalm of David in his
view, which says, that "the heavens declare the glory
of God, and the firmament sheweth his handywork."

The spacious firmament on high,
With all the blue ethereal sky,
And spangled heav'ns, a shining frame,
Their great original proclaim:
Th' unwearied sun, from day to day,
Does his Creator's pow'r display,
And publishes to ev'ry land
The work of an Almighty hand.

Soon as the ev'ning shades prevail,
The moon takes up the wond'rous tale,
And nightly to the list'ning earth
Repeats the story of her birth:
While all the stars that round her burn,
And all the planets in their turn,
Confirm the tidings as they roll,
And spread the truth from pole to pole.

What tho' in solemn silence all
Move round the dark terrestrial ball?
What tho' nor real voice or sound
Amid their radiant orb be found?
In reason's ear they all rejoice,
And utter forth a glorious voice,
For ever singing, as they shine,
"The hand that made us is divine."

The following pastoral hymn is a version of the 23d
Psalms by Mr Addison; the peculiar beauties of which
have occasioned many translations; but we have seen
none that is so poetical and perfect as this. And in
justice to Dr Boyce, we must observe, that the music
he has adapted to it is so sweet and expressive, that we
know not which is to be most admired, the poet or the
musician.

The Lord my pasture shall prepare,
And feed me with a shepherd's care;
His presence shall my wants supply,
And guard me with a watchful eye;
My noon-day walks he shall attend,
And all my midnight hours defend.
When in the sultry glebe I faint,
Or on the thirsty mountain pant,
To fertile vales and dewy meads
My weary wand'ring steps he leads;
Where peaceful rivers soft and slow
Amid the verdant landscape flow.
Tho' in the paths of death I tread,
With gloomy horrors overspread,

My steadfast heart shall fear no ill :
For thou, O Lord, art with me still ;
Thy friendly crook shall give me aid,
And guide me through the dreadful shade.
'Tho' in a bare and rugged way,
Through devious lonely wilds I stray,
Thy bounty shall my pains beguile :
The barren wilderness shall smile,
With sudden greens and herbage crown'd ;
And streams shall murmur all around.

III. We are now to speak of those odes which are of the sublime and noble kind, and distinguished from others by their elevation of thought and diction, as well by the variety or irregularity of their numbers as the frequent transitions and bold excursions with which they are enriched.

To give the young student an idea of the sudden and frequent transitions, digressions, and excursions, which are admitted into the odes of the ancients, we cannot do better than refer him to the celebrated song or ode of Moses ; which is the oldest that we know of, and was penned by that divine author immediately after the children of Israel crossed the Red-Sea.

At the end of this song, we are told, that " Miriam the prophetess, the sister of Aaron, took a timbrel in her hand, and all the women went out after her with timbrels and with dances. And Miriam answered them, Sing ye to the Lord, for he hath triumphed gloriously ; the horse and his rider hath he thrown into the sea."

From this last passage it is plain, that the ancients very early called in music to the aid of poetry ; and that their odes were usually sung, and accompanied with their lutes, harps, lyres, timbrels, and other instruments : nay, so essential, and in such reputation, was music held by the ancients, that we often find in their lyric poets, addresses or invocations to the harp, the lute, or the lyre ; and it was probably owing to the frequent use made of the last-mentioned instrument with the ode, that this species of writing obtained the name of *Lyric poetry*.

This ode, or hymn, which some believe was composed by Moses in Hebrew verse, is incomparably better than any thing the heathen poets have produced of the kind, and is by all good judges considered as a masterpiece of ancient eloquence. The thoughts are noble and sublime : the style is magnificent and expressive : the figures are bold and animated : the transitions and excursions are sudden and frequent : but they are short, and the poet, having digressed for a moment, returns immediately to the great object that excited his wonder, and elevated his soul with joy and gratitude. The images fill the mind with their greatness, and strike the imagination in a manner not to be expressed.

If there be any thing that in sublimity approaches to it, we must look for it in the east, where perhaps we shall find nothing superior to the following Hindoo hymn to *Narayana*, or " the spirit of God," taken, as Sir William Jones informs us, from the writings of the ancient Bramins.

Spirit of spirits, who, through every part
Of space expanded, and of endless time,
Beyond the reach of lab'ring thought sublime,
Badst uproar into beauteous order start ;

Before heav'n was, thou art.

Ere spheres beneath us roll'd, or spheres above,
Ere earth in firmamental æther hung,
'Thou sat'st alone, till, through thy mystic love,
'Things unexisting to existence sprung,

And grateful descant sung.

Omniscient Spirit, whose all-ruling pow'r
Bids from each sense bright emanations beam ;
Glows in the rainbow, sparkles in the stream,
Smiles in the bud, and gliten's in the flow'r

That crowns each vernal bow'r ;

Sighs in the gale, and warbles in the throat
Of every bird that hails the bloomy spring,
Or tells his love in many a liquid note,
Whilst envious artists touch the rival string,

Till rocks and forests ring ;

Breathes in rich fragrance from the Sandal grove,
Or where the precious musk-deer playful rove ;
In dulcet juice, from clust'ring fruit distils,
And burns salubrious in the tasteful clove :

Soft banks and verd'rous hills

Thy present influence fills ;

In air, in floods, in caverns, woods, and plains,
Thy will inspirits all, thy sovereign Maya reigns.
Blue crystal vault, and elemental fires,

That in th' ethereal fluid blaze and breathe ;
Thou, tossing main, whose snaky branches wreath
This pensile orb with intertwisting gyres ;

Mountains, whose lofty spires,
Presumptuous, rear their summits to the skies,
And blend their em'rald hue with sapphire light ;
Smooth meads and lawns, that glow with varying dyes
Of dew-bespangled leaves and blossoms bright,
Hence! vanish from my sight

Delusive pictures! unsubstantial shows !

My soul absorb'd one only Being knows,
Of all perceptions one abundant source,
Whence ev'ry object, ev'ry moment flows :

Suns hence derive their force,

Hence planets learn their course ;

But suns and fading worlds I view no more ;

God only I perceive ; God only I adore (F).

We come now to the *Pindaric ode*, which (if we except the hymns in the Old Testament, the psalms of king David, and such hymns of the Hindoos as that just quoted) is the most exalted part of Lyric poetry ; and was so called from *Pindar*, an ancient Greek poet, who is celebrated for the boldness of his flights, the impetuosity of his style, and the seeming wildness and irregularity that runs through his compositions, and which are said to be the effect of the greatest art. See *PINDAR*.

The odes of Pindar were held in such high estimation by the ancients, that it was fabled, in honour of their sweetness, that the bees, while he was in the cradle, brought

(F) For the philosophy of this ode, which represents the Deity as the soul of the world, or rather as the only Being (the *to iv* of the Greeks), see *ΜΕΤΑΦΥΣΙCS*, n° 269. and *PHILOSOPHY*, n° 6.

Of Lyric
Poetry.

brought honey to his lips: nor did the victors at the Olympic and other games think the crown a sufficient reward for their merit, unless their achievements were celebrated in Pindar's songs; most wisely presaging, that the first would decay, but the other endure for ever.

This poet did not always write his odes in the same measure, or with the same intention with regard to their being sung. For the ode inscribed to Diagoras (the concluding stanza of which we inserted at the beginning of this section) is in heroic measure, and all the stanzas are equal: there are others also, as Mr West observes, made up of *strophes* and *antistrophes*, without any *epode*; and some composed of *strophes* only, of different lengths and measures: but the greatest part of his odes are divided into *strophe*, *antistrophe*, and *epode*; in order, as Mr Congreve conjectures, to their being sung, and addressed by the performers to different parts of the audience. "They were sung (says he) by a chorus, and adapted to the lyre, and sometimes to the lyre and pipe. They consisted oftentimes of three stanzas. The first was called the *strophe*, from the version or circular motion of the fingers in that stanza from the right hand to the left. The second stanza was called the *antistrophe*, from the contraversion of the chorus; the fingers in performing that, turning from the left hand to the right, contrary always to their motion in the *strophe*. The third stanza was called the *epode* (it may be as being the after-song), which they sung in the middle, neither turning to one hand

*Vid. Pref.
to West's
Pindar.

nor the other. But Dr West's* friend is of opinion, that the performers also danced one way while they were singing the *strophe*, and danced back as they sung the *antistrophe*, till they came to the same place again, and then standing still they sung the *epode*. He has translated a passage from the *Scholia* on *Hephestion*, in proof of his opinion; and observes, that the dancing the *strophe* and *antistrophe* in the same space of ground, and we may suppose the same space of time also, shows why those two parts consisted of the same length and measure.

As the various measures of Pindar's odes have been the means of so far misleading some of our modern poets, as to induce them to call compositions Pindaric odes, that were not written in the method of Pindar, it is necessary to be a little more particular on this head, and to give an example from that poet, the more effectually to explain his manner; which we shall take from the translation of Dr West.

The eleventh NEMEAN ODE.

This ode is inscribed to Aristagoras, upon occasion of his entering on his office of president or governor of the island of Tenedos: so that, although it is placed among the Nemean odes, it has no sort of relation to those games, and is indeed properly an inauguration ode, composed to be sung by a chorus at the sacrifices and the feasts made by Aristagoras and his colleagues, in the town-hall, at the time of their being invested with the magistracy, as is evident from many expressions in the first *strophe* and *antistrophe*.

ARGUMENT.

Pindar opens this ode with an invocation to Vesta (the goddess who presided over the courts of justice, and whose statue and altar were for that reason placed in the town-halls, or *Prytaneums*, as the Greeks called them),

Of Lyric
Poetry.

beseeching her to receive favourably Aristagoras and his colleagues, who were then coming to offer sacrifices to her, upon their entering on their office of Prytans or magistrates of Tenedos; which office continuing for a year, he begs the goddess to take Aristagoras under her protection during that time, and to conduct him to the end of it without trouble or disgrace. From Aristagoras, Pindar turns himself in the next place to his father Arcefilas, whom he pronounces happy, as well upon account of his son's merit and honour, as upon his own great endowments and good fortune; such as beauty, strength, courage, riches, and glory, resulting from his many victories in the games. But lest he should be too much puffed up with these praises, he reminds him at the same time of his mortality, and tells him that his clothing of flesh is perishable, that he must e'er long be clothed with earth, the *end of all things*: and yet, continues he, it is but justice to praise and celebrate the worthy and deserving, who from good citizens ought to receive all kinds of honour and commendation; as Aristagoras, for instance, who hath rendered both himself and his country illustrious by the many victories he hath obtained, to the number of sixteen, over the neighbouring youth, in the games exhibited in and about his own country. From whence, says the poet, I conclude he would have come off victorious even in the Pythian and Olympic games, had he not been restrained from engaging in those famous lists by the too timid and cautious love of his parents. Upon which he falls into a moral reflection upon the vanity of man's hopes and fears; by the former of which they are oftentimes excited to attempts beyond their strength, which accordingly issue in their disgrace; as, on the other hand, they are frequently restrained, by unreasonable and ill-grounded fears, from enterprises, in which they would in all probability have come off with honour. This reflection he applies to Aristagoras, by saying it was very easy to foresee what success he was like to meet with, who both by father and mother was descended from a long train of great and valiant men. But here again, with a very artful turn of flattery to his father Arcefilas, whom he had before represented as strong and valiant, and famous for his victories in the games, he observes that every generation, even of a great and glorious family, is not equally illustrious any more than the fields and trees are every year equally fruitful; that the gods had not given mortals any certain tokens by which they might foreknow when the *rich years of virtue should succeed*; whence it comes to pass, that men, out of self-conceit and presumption, are perpetually laying schemes, and forming enterprises, without previously consulting prudence or wisdom, whose *streams*, says he, lie remote and out of the common road. From all which he infers, that it is better to moderate our desires, and set bounds to our avarice and ambition; with which moral precept he concludes the ode.

STROPHE I.

Daughter of Rhea! thou, whose holy fire
Before the awful seat of justice flames!
Sister of heav'n's almighty fire!
Sister of Juno, who coequal claims
With Jove to share the empire of the gods!
O virgin Vesta! to thy dread abodes,

Lo!

Lo! Aristagoras directs his pace!
Receive and near thy sacred sceptre place
Him, and his colleagues, who, with honest zeal,
O'er Tenedos preside, and guard the public weal.

ANTISTROPHE I.

And lo! with frequent off'rings, they adore
Thee*, first invoc'd in ev'ry solemn pray'r!
To thee unmix'd libations pour,
And fill with od'rous fumes the fragrant air.
Around in festive songs the hymning choir
Mix the melodious voice and sounding lyre,
While still, prolong'd with hospitable love,
Are solemniz'd the rites of genial Jove:
Then guard him, Vesta, through his long career,
And let him close in joy his ministerial year.

EPODE I.

But hail, Arcefilas! all hail
To thee, blest'd father of a son so great!
Thou whom on fortune's highest scale
The favourable hand of heav'n hath set,
Thy manly form with beauty hath refin'd,
And match'd that beauty with a valiant mind.
Yet let not man too much presume,
Tho' grac'd with beauty's fairest bloom;
Tho' for superior strength renown'd;
Tho' with triumphal chaplets crown'd:
Let him remember, that, in flesh array'd,
Soon shall he see that mortal vestment fade;
Till lost, imprison'd in the mould'ring urn,
To earth, the end of all things, he return.

STROPHE II.

Yet should the worthy from the public tongue
Receive their recompense of virtuous praise;
By ev'ry zealous patriot sung,
And deck'd with ev'ry flow'r of heav'nly lays.
Such retribution in re-urn for fame,
Such, Aristagoras, thy virtues claim,
Claim from thy country; on whose glorious brows
The wrestler's chaplet still unfaded blows;
Mix'd with the great Pancratiastic crown,
Which from the neighb'ring youth thy early valour won.

ANTISTROPHE II.

And (but his timid parents' cautious love,
Disturbing ever his too forward hand,
Forbad their tender son to prove
The toils of Pythia or Olympia's sands),
Now by the Gods I swear, his valorous might
Had escap'd victorious in each bloody fight;
And from Castalia†, or where dark with shade
The mount of Saturn ‡ rears its olive head,
Great and illustrious home had he return'd;
While, by his fame eclips'd, his vanquish'd foes had
[mourn'd.]

EPODE II.

Then his triumphal tresses bound
With the dark verdure of th' Olympic grove,
With joyous banquets had he crown'd
The great quinquennial festival of Jove;
And cheer'd the solemn pomp with choral lays,
Sweet tribute, which the muse to virtue pays.

But, such is man's prepost'rous fate!
Now, with o'er-weening pride elate,
Too far he aims his shaft to throw,
And straining bursts his feeble bow:
Now pusillanimous depress'd with fear,
He checks his virtue in the mid career;
And of his strength distrustful, coward flies
The contest, tho' empow'rd to gain the prize.

STROPHE III.

But who could err in prophesying good
Of him, whose undegenerating breast
Swells with a tide of Spartan blood,
From fire to fire in long succession trac'd
Up to Pisander; who in days of yore
From old Amyclæ to the Lesbian shore
And Tenedos, collegu'd in high command
With great Oristes, led th' Æolian band?
Nor was his mother's race less strong and brave,
Sprung from a stock that grew on fair* Ismenus' wave.

ANTISTROPHE III.

Tho' for long intervals obscur'd, again
Oft-times the seeds of lineal worth appear.
For neither can the furrow'd plain
Full harvests yield with each returning year;
Nor in each period will the pregnant bloom
Invest the smiling tree with rich perfume.
So, barren often, and inglorious, pass
The generations of a noble race;
While nature's vigour, working at the root,
In after-ages swells, and blossoms into fruit.

EPODE III.

Nor hath Jove giv'n us to foreknow
When the rich years of virtue shall succeed:
Yet bold and daring on we go,
Contriving schemes of many a mighty deed;
While hope, fond inmate of the human mind,
And self-opinion, active, rash, and blind,
Hold up a false illusive ray,
That leads our dazzled feet astray
Far from the springs, where, calm and slow,
The secret streams of wisdom flow.
Hence should we learn our ardour to restrain,
And limit to due bounds the thirst of gain.
To rage and madness oft that passion turns,
Which with forbidden flames despairing burns.

From the above specimen, and from what we have¹³¹ already said on this subject, the reader will perceive, that odes of this sort are distinguished by the happy transitions and digressions which they admit, and the surprising yet natural returns to the subject. This requires great judgment and genius; and the poet who would excel in this kind of writing, should draw the plan of his poem, in manner of the argument we have above inserted, and mark out the places where those elegant and beautiful sallies and wanderings may be made, and where the returns will be easy and proper.

Pindar, it is universally allowed, had a poetical and fertile imagination, a warm and enthusiastic genius, a bold and figurative expression, and a concise and sententious style: but it is generally supposed that many of those pieces which procured him such extravagant praises

It was usual in all solemn sacrifices and prayers to invoke Vesta.

† A river, upon whose banks the Pythian games were exhibited.
‡ A small hill planted with olives, that overlooked the Stadium at Olympia

* Ismenus was a river of Boeotia, of which country was Menalippus, the ancestor of Aristagoras by the mother's side.

¹³¹ Distin- guishing characters of it.

praises and extraordinary testimonies of esteem from the ancients are lost; and if they were not, it would be perhaps impossible to convey them into our language; for beauties of this kind, like plants of an odoriferous and delicate nature, are not to be transplanted into another clime without losing much of their fragrance or essential quality.

132
Modern
odes com-
monly cal-
led Pin-
danic.

With regard to those compositions which are usually called *Pindaric odes*, (but which ought rather to be distinguished by the name of *irregular odes*), we have many in our language that deserve particular commendation: and the criticism Mr Congreve has given us on that subject, has too much asperity and too great latitude; for if other writers have, by mistaking Pindar's measures, given their odes an improper title, it is a crime, one would think, not so dangerous to the commonwealth of letters as to deserve such severe reproof. Beside which, we may suppose that some of these writers did not deviate from Pindar's method through ignorance, but by choice; and that as their odes were not to be performed with both singing and dancing, in the manner of Pindar's, it seemed unnecessary to confine the first and second stanzas to the same exact numbers as was done in his strophes and antistrophes. The poet therefore had a right to indulge himself with more liberty: and we cannot help thinking, that the ode which Mr Dryden has given us, intitled, *Alexander's Feast, or the Power of Music*, is altogether as valuable in loose and wild numbers, as it could have been if the stanzas were more regular, and written in the manner of Pindar. In this ode there is a wonderful sublimity of thought, a loftiness and sweetness of expression, and a most pleasing variety of numbers.

'Twas at the royal feast, for Persia won
By Philip's warlike son,
Aloft, in awful state,
The god-like hero sat
On his imperial throne:
His valiant peers were plac'd around:
Their brows with roses and with myrtles bound,
(So should desert in arms be crown'd:)
The lovely Thais by his side
Sat like a blooming eastern bride,
In flow'r of youth and beauty's pride.
Happy, happy, happy pair!
None but the brave,
None but the brave,
None but the brave deserve the fair.

Chor. *Happy, happy, &c.*

Timotheus, plac'd on high
Amid the tuneful quire,
With dying fingers touch'd the lyre:
The trembling notes ascend the sky,
And heav'nly joys inspire.
The song began from Jove,
Who left his blissful seats above,
(Such is the pow'r of mighty love!)
A dragon's fiery form bely'd the God:
Sublime on radiant spires he rode,
When he to fair Olympia press'd;
And while he fought her snowy breast:
Then round her slender waist he curl'd,
And stamp'd an image of himself, a sov'reign of
the world.
The list'ning crowd admire the lofty sound.

A present deity, they shout around;
A present deity, the vaulted roofs rebound:
With ravis'd ears
The monarch hears,
Assumes the God,
Affects to nod,
And seems to shake the spheres.

Chor. *With ravis'd ears, &c.*

The praise of Bacchus then the sweet musician sung;
Of Bacchus ever fair and ever young:
The jolly God in triumph comes;
Sound the trumpets, beat the drums:
Flush'd with a purple grace,
He shows his honest face:
Now give the hautboys breath; he comes, he comes!
Bacchus, ever fair and young,
Drinking joys did first ordain:
Bacchus' blessings are a treasure,
Drinking is the soldier's pleasure:
Rich the treasure,
Sweet the pleasure:
Sweet the pleasure after pain.

Chor. *Bacchus' blessings, &c.*

Sooth'd with the sound, the king grew vain,
Fought all his battles o'er again;
And thrice he routed all his foes, and thrice he
slew the slain.
The master saw the madness rise;
His glowing cheeks, his ardent eyes;
And while he heav'n and earth defy'd,
Chang'd his hand, and check'd his pride.
He chose a mournful muse
Soft pity to infuse:
He sung Darius great and good,
By too severe a fate,
Fallen, fallen, fallen, fallen,
Fallen from his high estate,
And welt'ring in his blood;
Deserted at his utmost need,
By those his former bounty fed,
On the bare earth expos'd he lies,
With not a friend to close his eyes.
With down-cast looks the joyless victor sat,
Revolving in his alter'd soul
The various turns of chance below;
And now and then a sigh he stole,
And tears began to flow.

Cho. *Revolving, &c.*

The mighty master smil'd to see
That love was in the next degree:
'Twas but a kindred sound to move;
For pity melts the mind to love,
Softly sweet, in Lydian measures:
Soon he sooth'd his soul to pleasures.
War, he sung, is toil and trouble;
Honour but an empty bubble,
Never ending, still beginning,
Fighting still, and still destroying.
If the world be worth thy winning,
Think, O think, it worth enjoying.
Lovely Thais sits beside thee,
Take the good the gods provide thee.
The many rend the skies with loud applause;
So love was crown'd, but music won the cause.
The prince, unable to conceal his pain,

Gaz'd

Gaz'd on the fair,
Who caus'd his care,
And sigh'd and look'd, sigh'd and look'd,
Sigh'd and look'd, and sigh'd again:
At length with love and wine at once oppress'd,
The vanquish'd victor sunk upon her breast.

Chor. *The prince, &c.*

Now strike the golden lyre again;
A louder yet, and yet a louder strain.
Break his bands of sleep asunder,
And rouse him, like a rattling peal of thunder.
Hark! hark! the horrid sound
Has rais'd up his head,
As awake from the dead,
And amaz'd he stares round.
Revenge, revenge, Timotheus cries;
See the furies arise:
See the snakes that they rear,
How they hiss in their hair,
And the sparkles that flash from their eyes;
Behold a ghastly band,
Each a torch in his hand!
Those are Grecian ghosts that in battle were slain,
And unbury'd remain,
Inglorious on the plain.
Give the vengeance due
To the valiant crew.
Behold how they toss their torches on high,
How they point to the Persian abodes,
And glitt'ring temples of their hostile gods.
The princes applaud with a furious joy;
And the king seiz'd a flambeau, with zeal to destroy;
Thais led the way
To light him to his prey,
And, like another Helen, she fir'd another Troy.

Chor. *And the king seiz'd, &c.*

Thus long ago,
While organs yet were mute;
Timotheus, to his breathing flute,
And sounding lyre,
Could swell the soul to rage, or kindle soft desire.
At last divine Cecilia came,
Inventress of the vocal frame;
The sweet enthusiast, from her sacred store,
Enlarg'd the former narrow bounds,
And added length to solemn sounds,
With nature's mother-wit, and arts unknown before.
Let old Timotheus yield the prize
Or both divide the crown;
He rais'd a mortal to the skies;
She drew an angel down.

Grand chor. *At last, &c.*

There is another poem by Dryden, on the death of Mrs Anne Killegrew, a young lady eminent for her skill in poetry and painting, which a great critic* has pronounced to be "undoubtedly the noblest ode that our language has ever produced." He owns, that as a whole it may perhaps be inferior to *Alexander's Feast*; but he affirms that the first stanza of it is superior to any single part of the other. This famous stanza, he says, flows with a torrent of enthusiasm: *Pervet immensusque ruit*. How far this criticism is just, the public must determine.

Vol. XV. Part I.

I.

Thou youngest virgin-daughter of the skies,
Made in the last promotion of the bless'd;
Whose palms, new-pluck'd from Paradise,
In spreading branches more sublimely rise,
Rich with immortal green above the rest;
Whetlier, adopted to some neighb'ring star,
Thou roll'st above us, in thy wand'ring race,
Or in procession fix'd and regular,
Mov'd with the heav'n's majestic pace;
Or, call'd to more superior bliss,
Thou tread'st with seraphims the vast abyss:
Whatever happy region is thy place,
Cease thy celestial song a little space;
Thou wilt have time enough for hymns divine,
Since heaven's eternal year is thine.
Hear then a mortal muse thy praise rehearse
In no ignoble verse;
But such as thy own voice did practise here,
When thy first fruits of poetry were giv'n
To make thyself a welcome inmate there;
While yet a young probationer,
And candidate of heav'n.

II.

If by traduction came thy mind,
Our wonder is the less to find
A soul so charming from a stock so good;
Thy father was transfus'd into thy blood,
So wert thou born into a tuneful strain,
An early, rich, and inexhausted vein.
But, if thy pre-existing soul
Was form'd at first with myriads more,
It did through all the mighty poets roll,
Who Greek or Latin laurels wore,
And was that Sappho last which once it was before.
If so, then cease thy flight, O heaven-born mind!
Thou hast no drops to purge from thy rich ore,
Nor can thy soul a fairer mansion find,
Than was the beauteous frame she left behind:
Return to fill or mend the choir of thy celestial kind.

III.

May we presume to say, that, at thy birth,
New joy was sprung in heav'n, as well as here on earth?
For sure the milder planets did combine
On thy auspicious horoscope to shine,
An e'en the most malicious were in trine.
Thy brother-angels at thy birth
Strung each his lyre, and tun'd it high,
That all the people of the sky
Might know a poetess was born on earth.
And then, if ever, mortal ears
Had heard the music of the spheres.
And if no clust'ring swarm of bees
On thy sweet mouth distill'd their golden dew,
'Twas that such vulgar miracles
Heav'n had not leisure to renew:
For all thy bless'd fraternity of love
Solemniz'd there thy birth, and kept thy holy day above.

IV.

O gracious God! how far have we
Profan'd thy heav'nly gift of poetry?
Made prostitute and profligate the Muse,
Debas'd to each obscene and impious use,

F f

Whose

Of Lyric
Poetry.

Whose harmony was first ordain'd above
For tongues of angels, and for hymns of love?
O wretched we! why were we hurry'd down
This lubrique and adult'rate age,
(Nay added fat pollutions of our own)
T'increase the streaming ordures of the stage!
What can we say t'excuse our second fall?
Let this thy vestal, Heav'n, atone for all:
Her Arethusian stream remains unsoil'd,
Unmix'd with foreign filth, and undefil'd;
Her wit was more than man, her innocence a child.

V.

Art she had none, yet wanted none;
For nature did that want supply:
So rich in treasures of her own,
She might our boasted stores defy:
Such noble vigour did her verse adorn,
That it seem'd borrow'd where 'twas only born.
Her morals, too, were in her bosom bred,
By great examples daily fed,
What in the best of books, her father's life she read.
And to be read herself, she need not fear;
Each test, and every light, her Muse will bear,
Tho' Epictetus with his lamp were there.
E'en love (for love sometimes her Muse express'd)
Was but a lambent flame which play'd about her breast,
Light as the vapours of a morning dream,
So cold herself, while she such warmth express'd,
'Twas Cupid bathing in Diana's stream.

VI.

Born to the spacious empire of the Nine,
One would have thought she should have been content
To manage well that mighty government;
But what can young ambitious souls confine?
To the next realm she stretch'd her sway,
For *Painture* near adjoining lay,
A plenteous province and alluring prey.
A *Chamber of Dependencies* was fram'd,
(As conquerors will never want pretence,
When arm'd, to justify th' offence)
And the whole sief, in right of poetry, she claim'd.
The country open lay without defence:
For poets frequent inroads there had made,
And perfectly could represent
The shape, the face, with ev'ry lincament,
And all the large domains which the *dumb sifter* sway'd.
All bow'd beneath her government,
Receiv'd in triumph wheresoe'er she went.
Her pencil drew whate'er her soul design'd,
And oft the happy draught surpass'd the image in her mind.
The sylvan scenes of herds and flocks,
And fruitful plains and barren rocks,
Of shallow brooks that flow'd so clear,
The bottom did the top appear;
Of deeper too, and ampler floods,
Which, as in mirrors, show'd the woods:
Of lofty trees, with sacred shades,
And perspectives of pleasant glades,
Where nymphs of brightest form appear,
And shaggy satyrs standing near,
Which them at once admire and fear.
The ruins too of some majestic piece,
Boasting the power of ancient Rome or Greece,
Whose statues, freezes, columns, broken lie,
And, though defac'd, the wonder of the eye;

What nature, art, bold fiction, e'er durst frame,
Her forming hand gave feature to the name.
So strange a concurrence ne'er was seen before,
But when the peopl'd ark the whole creation bore.

VII.

The scene then chang'd, with bold erected look
Our martial king the sight with reverence struck:
For not content t'express his outward part
Her hand call'd out the image of his heart:
His warlike mind, his soul devoid of fear,
His high-designing thoughts were figur'd there,
As when, by magic, ghosts are made appear.
Our phoenix queen was pourtray'd too so bright,
Beauty alone could beauty take so right:
Her dress, her shape, her matchless grace,
Were all observ'd, as well as heav'nly face.
With such a peerless majesty she stands,
As in that day she took the crown from sacred hands;
Before a train of heroines was seen,
In beauty foremost, as in rank, the queen.
Thus nothing to her genius was denied,
But like a ball of fire the further thrown,
Still with a greater blaze she shone,
And her bright soul broke out on ev'ry side.
What next she had design'd, Heav'n only knows:
To such immod'rate growth her conquest rose,
That fate alone its progress could oppose.

VIII.

Now all those charms, that blooming grace,
The well proportion'd shape, and beauteous face,
Shall never more be seen by mortal eyes;
In earth the much lamented virgin lies.
Nor wit nor piety could fate prevent;
Nor was the cruel *Destiny* content
To finish all the murder at a blow,
To sweep at once her life and beauty too;
But, like a harden'd felon, took a pride
To work more mischievously slow,
And plunder'd first, and then destroy'd,
O double sacrilege on things divine,
To rob the relic, and deface the shrine!
But thus Orinda died:
Heav'n, by the same disease, did both translate;
As equal were their souls, so equal was their fate.

IX.

Meantime her warlike brother on the seas
His waving streamers to the winds displays,
And vows for his return, with vain devotion, pays.
Ah generous youth! that wish forbear,
The winds too soon will waft thee here!
Slack all thy sails, and fear to come,
Alas, thou know'st not, thou art wreck'd at home!
No more shalt thou behold thy sifter's face,
Thou hast already had her last embrace.
But look aloft, and if thou kenn'st from far,
Among the Pleiads a new-kindled star,
If any sparkles than the rest more bright,
'Tis she that shines in that propitious light.

X.

When in mid-air the golden trump shall sound,
To raise the nations under ground;
When in the valley of Jehoshaphat,
The judging God shall close the book of fate;
And there the last *assizes* keep
For those who wake and those who sleep:

When

Of Lyric
Poetry.

When rattling bones together fly
From the four corners of the sky ;

When sinews o'er the skeletons are spread,
Those cloth'd with flesh, and life inspires the dead ;
The sacred poets first shall hear the sound,

And foremost from the tomb shall bound,
For they are cover'd with the lightest ground ;
And straight with in-born vigour, on the wing,
Like mounting larks to the new morning sing.
There thou, sweet faint, before the quire shalt go
As harbinger of heav'n, the way to show,
The way which thou so well hast learnt below.

That this is a fine ode, and not unworthy of the genius of Dryden, must be acknowledged ; but that it is the noblest which the English language has produced, or that any part of it runs with the torrent of enthusiasm which characterizes *Alexander's Feast*, are positions which we feel not ourselves inclined to admit. Had the critic by whom it is so highly praised, inspected it with the eye which scanned the odes of Gray, we cannot help thinking that he would have perceived some parts of it to be tediously minute in description, and others not very perspicuous at the first perusal. It may perhaps, upon the whole, rank as high as the following ode by Collins on the Popular Superstitions of the Highlands of Scotland ; but to a higher place it has surely no claim.

I.

HOME, thou return'st from Thames, whose Naiads long
Have seen thee ling'ring with a fond delay,

Mid those soft friends, whose hearts some future day,
Shall melt, perhaps, to hear thy tragic song,
Go, not unmindful of that cordial youth (G)

Whom, long endear'd, thou leav'st by Lavant's side ;
Together let us wish him lasting truth,
And joy untainted with his destin'd bride.

Go ! nor regardless, while these numbers boast

My short-liv'd bliss, forget my social name ;
But think, far off, how, on the southern coast,

I met thy friendship with an equal flame !

whose.

Fresh to that soil thou turn'st, where * ev'ry vale
Shall prompt the poet, and his song demand :

To thee thy copious subjects ne'er shall fail ;

Thou need'st but take thy pencil to thy hand,
And paint what all believe who own thy genial land.

II.

There must thou wake perforce thy Doric quill ;

'Tis fancy's land to which thou sett'st thy feet ;

Where still, 'tis said, the Fairy people meet,
Beneath each birken shade, on mead or hill.

There, each trim lass, that skims the milky store,

To the swart tribes their creamy bowl allots ;

By night they sip it round the cottage-door,
While airy minstrels warble jocund notes.

There, ev'ry herd, by sad experience, knows,

How, wing'd with Fate, their elf-shot arrows fly,

When the sick ewe her summer food foregoes,

Or, stretch'd on earth, the heart-smit heifers lie.

Such airy beings awe th' untutor'd swain :

Nor thou, tho' learn'd, his homelier thoughts neglect :

Let thy sweet Muse the rural faith sustain ;

These are the themes of simple, sure effect,

That add new conquests to her boundless reign,

And fill, with double force, her heart-commanding
III. [strain.

Ev'n yet preserv'd, how often may'st thou hear,

Where to the pole the Boreal mountains run,

Taught by the father to his list'ning son,

Strange lays, whose pow'r had charm'd a Spenser's ear.

At ev'ry pause, before thy mind possest,

Old Runic bards shall seem to rise around,

With uncouth lyres in many-colour'd vest,

Their matted hair with boughs fantastic crown'd :

Whether thou bid'st the well-taught hind repeat

The choral dirge that mourns some chieftain brave,

When ev'ry shrieking maid her bosom beat,

And strew'd with choicest herbs his scented grave ;

Or whether sitting in the shepherd's shiel (H),

Thou hear'st some sounding tale of war's alarms, † bony.

When, at the bugle's call, with fire and steel,

The sturdy clans pour'd forth their *braavy* † swarms,

And hostile brothers met to prove each other's arms.

IV.

'Tis thine to sing how framing hideous spells,

In Sky's lone isle the gifted wizzard-seer §,

Lodg'd in the wintry cave with Fate's fell spear (I),

Or in the depth of Uist's dark forest dwells :

How they whose sight such dreary dreams engross,

With their own visions oft astonish'd droop, † embodied.

When, o'er the wat'ry strath, or quaggy moss,

They see the gliding ghosts *unbodied* † troop. † piercing.

Or, if in sports, or on the festive green,

Their *destin'd* † glance some fated youth descry,

Who now, perhaps, in lusty vigour seen,

And rosy health, shall soon lamented die.

For them the viewless forms of air obey ;

Their bidding heed, and at their beck repair.

They know what spirit brews the stormful day,

And heartless, oft like moody madness, stare

To see the phantom train their secret work prepare.

V.

To monarchs dear (K), some hundred miles astray,

Oft have they seen Fate give the fatal blow !

The seer in Sky shriek'd as the blood did flow

When headless Charles warm on the scaffold lay !

F f 2

A9

(G) A gentleman of the name of *Barrow*, who introduced Home to Collins.

(H) A summer hut, built in the high part of the mountains, to tend their flocks in the warm season, when the pasture is fine.

(I) Waiting in wintry cave his wayward fits.

(K) Of this beautiful ode two copies have been printed : one by Dr Carlyle, from a manuscript which he acknowledges to be mutilated ; another by an editor who seems to hope that a nameless somebody will be believed, when he declares, that " he discovered a *perfect copy* of this admirable ode among some old papers in the concealed drawers of a bureau left him by a relation." The present age has been already too much amused with pretended discoveries of poems in the bottoms of *old chests*, to pay full credit to an assertion of this kind, even though
the

Of Lyric
Poetry.

As Boreas threw his young Aurora (L) forth,
In the first year of the first George's reign,
And battles rag'd in welkin of the North,
They mourn'd in air, fell, fell rebellion, slain !
And as of late they joy'd in Preston's fight,
Saw at sad Falkirk all their hopes near crown'd !
They rav'd divining through their second-sight (M),
Pale, red Culloden, where these hopes were drown'd !
Illustrious William (N) ! Britain's guardian name !
One William sav'd us from a tyrant's stroke ;
He, for a sceptre, gain'd heroic fame,
But thou, more glorious, Slavery's chain hast broke,
To reign a private man, and bow to Freedom's yoke !

VI.

These, too, thou'lt sing ! for well thy magic muse
Can to the topmost heav'n of grandeur soar !
Or stoop to wail the swain that is no more !
Ah, homely swains ! your homeward steps ne'er loose ;
Let not dank *Will* (O) mislead you to the heath :
Dancing in mirky night, o'er fen and lake,
He glows, to draw you downward to your death,
In his bewitch'd, low, marshy, willow brake !
What though far off, from some dark dell espied,
His glimm'ring mazes cheer th' excursive fight,
Yet turn, ye wand'ers, turn your steps aside,
Nor trust the guidance of that faithless light ;
For watchful, lurking, 'mid th' unrustling reed,
At those mirk hours the wily monster lies,
And listens oft to hear the passing steed,
And frequent round him rolls his sullen eyes,
If chance his savage wrath may some weak wretch surprise.

VII.

Ah, luckless swain, o'er all unblest, indeed !
Whom late bewilder'd in the dank, dark fen,
Far from his flocks, and smoking hamlet, then !
To that sad spot * *where hums the sedgy weed.*

* his way-
ward fate
shall lead.Of Lyric
Poetry.

On him, enrag'd, the fiend, in angry mood,
Shall never look with pity's kind concern,
But instant, furious, raise the whelming flood
O'er its drown'd banks, forbidding all return !
Or, if he meditate his wish'd escape,
To some dim hill that seems uprising near,
To his faint eye, the grim and grisly shape,
In all its terrors clad, shall wild appear.
Meantime the wat'ry surge shall round him rise,
Pour'd sudden forth from ev'ry swelling source !
What now remains but tears and hopeless sighs ?
His fear-shook limbs have lost their youthly force,
And down the waves he floats, a pale and breathless corpse ;

VIII.

For him in vain his anxious wife shall wait,
Or wander forth to meet him on his way ;
For him in vain, at to-fall of the day,
His babes shall linger at th' unclosing gate !
Ah, ne'er shall he return ! Alone, if night,
Her travell'd limbs in broken slumbers sleep !
With drooping willows drest, his mournful sprite
Shall visit sad, perchance, her silent sleep :
Then he, perhaps, with moist and wat'ry hand,
Shall fondly seem to press her shudd'ring cheek,
And with his blue-swoln face before her stand,
And, shiv'ring cold, these piteous accents speak :
" Pursue, dear wife, thy daily toils pursue,
" At dawn or dusk, industrious as before ;
" Nor e'er of me one * *helpless* thought renew,
" While I lie welt'ring on the ozier'd shore,
" Drown'd by the kelpie's† wrath, nor e'er shall aid thee † the water
[more!]" fiend.

* hapless.

* style.

IX.

Unbounded is thy range ; with varied *skill* *
Thy muse may, like those feath'ry tribes which spring
From their rude rocks, extend her skirting wing
Round the moist marge of each cold Hebrid isle,

To

the scene of discovery be laid in a *bureau*. As the ode of the anonymous editor differs, however, very little from that of Dr Carlyle, and as what is affirmed by a GENTLEMAN may be true, though " he chooses not at present to publish his name," we have inserted into our work the copy which pretends to be perfect, noting at the bottom or margin of the page the different readings of Dr Carlyle's edition. In the Doctor's manuscript, which appeared to have been nothing more than the *prima cura*, or first sketch of the poem, the fifth stanza and half of the sixth were wanting ; and to give a continued context, he prevailed with Mr M'Kenzie, the ingenious author of the *Man of Feeling*, to fill up the chasm. This he did by the following beautiful lines, which we cannot help thinking much more happy than those which occupy their place in the copy said to be perfect :

" Or on some bellying rock that shades the deep,
They view the lurid signs that cross the sky,
Where in the west the brooding tempests lie ;
And hear their first, faint, rustling pennons sweep.
Or in the arched cave, where deep and dark
The broad unbroken billows heave and swell,
In horrid musings wrapt, they sit to mark
The lab'ring moon ; or list the nightly yell
Of that dread spirit, whose gigantic form
The seer's entranced eye can well survey,
Through the dim air who guides the driving storm,
And points the wretched bark its destin'd prey.
Or him who hovers on his flagging wing,

O'er the dire whirlpool, that in ocean's waste,
Draws instant down whate'er devoted thing
The falling breeze within its reach hath plac'd —
The distant seaman hears, and flies with trembling haste.

Or if on land the fiend exerts his sway,
Silent he broods o'er quicksand, bog, or fen,
Far from the shelt'ring roof and haunts of men,
When witch'd darkness shuts the eye of day,
And shrouds each star that wont to cheer the night ;
Or if the drifted snow perplex the way,
With treach'rous gleam he lures the fated wight
And leads him flound'ring on and quite astray."

(L) By young Aurora, Collins undoubtedly meant the first appearance of the northern lights, which is commonly said to have happened about the year 1715.

(M) Second-sight is the term that is used for the divination of the Highlanders.

(N) The late duke of Cumberland, who defeated the Pretender at the battle of Culloden.

(O) A fiery meteor, called by various names, such as *Will with the Wisp*, *Jack with the Lanthorn*, &c. It hovers in the air over marshy and fenny places.

To that hoar pile (p) which still its ruin shows:
In whose small vaults a pigmy-folk is found,
Whose bones the delver with his spade upthrows;
And culls them, wond'ring, from the hallow'd ground!
Or thither (q), where beneath the show'ry west,
The mighty kings of three fair realms are laid:
Once foes, perhaps, together now they rest,
No slaves revere them, and no wars invade:
Yet frequent now, at midnight solemn hour,
The rifted mounds their yawning cells unfold,
And forth the monarchs stalk with sov'reign pow'r
In pageant robes; and, wreath'd with sheeny gold,
And on their twilight tombs aerial council hold.

X.

But, oh! o'er all, forget not Kilda's race,
On whose bleak rocks, which brave the wafting tides,
Fair Nature's daughter, Virtue, yet abides.
Go! just, as they, their blameless manners trace!
Then to my ear transmit some gentle song,
Of those whose lives are yet sincere and plain,
Their bounded walks the rugged cliffs along,
And all their prospect but the wintry main.
With sparing temp'rance at the needful time,
They drain the scented spring; or, hunger-press'd,
Along th' Atlantic rock, undreading, climb,
And of its eggs despoil the Solan's nest*.
Thus, blest in primal innocence, they live,
Suffic'd, and happy with that frugal fare
Which tasteful toil and hourly danger give.
Hard is their shallow foil, and bleak and bare;
Nor ever vernal bee was heard to murmur there!

XI.

Nor need'st thou blush that such false themes engage
Thy gentle mind, of fairer stores poss'est;
For not alone they touch the village breast,
But fill'd in elder time th' historic page.
There, Shakespeare's self, with every garland crown'd,
Flaw to those fairy climes his fancy's been (r),
In musing hour; his wayward fifters found,
And with their terrors dress'd the magic scene.
From them he sung, when, 'mid his bold design,
Before the Scot, afflicted, and aghast!
The shadowy kings of Banquo's fated line,
Thro' the dark cave in gleamy pageant pass'd.
Proceed! nor quit the tales which, simply told,
Could once so well my answer'ing bosom pierce;
Proceed, in forceful sounds, and colours bold,
The native legends of thy land rehearse;
To such adapt thy lyre, and suit thy pow'ful verse.

XII.

In scenes like these, which, daring to depart
From sober truth, are still to nature true,
And call forth fresh delight to fancy's view,
Th' heroic muse employ'd her Tasso's art!

How have I trembl'd, when, at Tancred's stroke,
Its gushing blood the gaping cypress pour'd,
When each live plant with mortal accents spoke,
And the wild blast upheav'd the vanish'd sword!

How have I sat, when pip'd the pensive wind,
To hear his harp by British Fairfax strung!
Prevailing poet! whose undoubting mind,
Believ'd the magic wonders which he sung!

Hence, at each sound, imagination glows!
Hence, at each picture, vivid life starts here! (s)

Hence his warm lay with softest sweetness flows!
Melting it flows, pure, *murm'ring**, strong, and clear, * numerous.
And fills th' impassion'd heart, and wins th' harmonious
[ear!]

XIII.

All hail, ye scenes that o'er my soul prevail!
Ye *splendid*† friths and lakes, which, far away, † spacious.
Are by smooth Annan† fill'd, or past'ral Tay†, † Three rivers in
Or Don's† romantic springs, at distance, hail! Scotland.
The time shall come, when I, perhaps, may tread
Your lowly *glens*§, o'erhung with spreading broom; § valleys.
Or o'er your stretching heaths, by fancy led,
Or o'er your mountains creep, in awful gloom! (t)
Then will I dress once more the faded bow'r,
Where Jonson (v) sat in Drummond's *classic** shade; * social.
Or crop, from Tiviotdale, each lyric flow'r,
And mourn, on Yarrow's banks, *where Willy's laid*†! † the widow'd
Meantime, ye pow'rs that on the plains which bore maid!
The cordial youth, on Lothian's plains (x), attend!
Where'er *HOME dwells*†, on hill, or lowly moor, † he dwell.
To him I *loose*§, your kind protection lend, [friend! § lose.
And, touch'd with love like mine, preserve my absent

Dr Johnson, in his life of Collins, informs us, that
Dr Warton and his brother, who had seen this ode in
the author's possession, thought it superior to his other
works. The taste of the Wartons will hardly be ques-
tioned; but we are not sure that the following *Ode to*
the Passions has much less merit, though it be merit of a
different kind, than the Ode on the Superstitions of the
Highlands:

WHEN Music, heav'nly maid, was young,
While yet in early Greece she sung,
The Passions oft, to hear her shell,
Throng'd around her magic cell,
Exulting, trembling, raging, fainting,
Poss'est beyond the Muse's painting;
By turns they felt the glowing mind
Disturb'd, delighted, rais'd, refin'd.
Till once, 'tis said, when all were fir'd,
Fill'd with fury, rapt, inspir'd,
From the supporting myrtles round
They snatch'd her instruments of sound:
And as they oft had heard apart
Sweet lessons of her forceful art,

Each,

(p) One of the Hebrides is called the *Isle of Pigmies*, where it is reported, that several miniature bones of the human species have been dug up in the ruins of a chapel there.

(q) Icolmkill, one of the Hebrides, where many of the ancient Scottish, Irish, and Norwegian kings, are said to be interred.

(r) This line wanting in Dr Carlyle's edition.

(s) This line wanting in Dr Carlyle's edition.

(t) This line wanting in Dr Carlyle's edition.

(v) Ben Jonson paid a visit on foot in 1619 to the Scotch poet Drummond, at his seat of Hawthornden, within seven miles of Edinburgh.

(x) Barrow, it seems, was at the university of Edinburgh, which is in the county of Lothian.

Of Lyric
Poetry.Of Lyric
Poetry.

Each, for madness rul'd the hour,
Would prove his own expressive power.
First Fear his hand, its skill to try,
Amid the chords bewilder'd laid,
And back recoil'd, he knew not why,
Ev'n at the sound himself had made.
Next Anger rush'd; his eyes on fire,
In lightnings own'd his secret stings;
In one rude clasp he struck the lyre,
And swept with hurried hand the strings.
With woeful measures wan Despair—
Low fullen sounds his grief beguil'd;
A solemn, strange, and mingled air;
'Twas sad by fits, by starts 'twas wild.
But thou, O Hope! with eyes so fair,
What was thy delighted measure?
Still it whisper'd promis'd pleasure,
And bade the lovely scenes at distance hail!—
Still would her touch the strain prolong,
And from the rocks, the woods, the vale,
She call'd on Echo still through all her song;
And where her sweetest theme she chose,
A soft responsive voice was heard at every close,
And Hope enchanted smil'd, and wav'd her golden hair.
And longer had she sung;—but, with a frown,
Revenge impatient rose;
He threw his blood-stain'd sword in thunder down,
And, with a withering look,
The war-denouncing trumpet took,
And blew a blast so loud and dread,
Were ne'er prophetic sounds so full of woe.
And ever and anon he beat
The doubling drum with furious heat;
And though sometimes, each dreary pause between,
Dejected Pity at his side
Her soul-subduing voice applied,
Yet still he kept his wild unalter'd mien, [his head.
While each strain'd ball of sight seem'd bursting from
Thy numbers, Jealousy, to nought were fix'd,
Sad proof of thy distressful state;
Of differing themes the veering song was mix'd;
And now it courted Love, now raving call'd on Hate.
With eyes up-rais'd, as one inspir'd,
Pale Melancholy sat retir'd,
And from her wild sequester'd seat,
In notes by distance made more sweet,
Pour'd through the mellow horn her pensive soul,
And dashing soft from rocks around,
Bubbling runnels join'd the sound;
Through glades and glooms the mingled measure stole,
Or o'er some haunted streams with fond delay,
Round an holy calm diffusing,
Love of peace, and lonely musing,
In hollow murmurs died away.
But O! how alter'd was its sprightlier tone!
When Cheerfulness, a nymph of healthiest hue,
Her bow across her shoulder slung,
Her buskins gemm'd with morning dew,
Blew an inspiring air, that dale and thicket rung,
The hunter's call to Faun and Dryad known;
The oak-crown'd sisters, and their chaste-ey'd queen,

Satyrs and sylvan boys were seen,
Peeping from forth their alleys green;
Brown Exercise rejoic'd to hear,
And Sport leapt up, and seiz'd his beechen spear.
Last came Joy's ecstatic trial;
He, with viny crown advancing,
First to the lively pipe his hand address'd,
But soon he saw the brisk awakening viol,
Whose sweet entrancing voice he lov'd the best.
They would have thought who heard the strain,
They saw in Tempe's vale her native maids,
Amidst the festal founding shades,
To some unwearied minstrel dancing,
While, as his flying fingers kiss'd the strings,
Love fram'd with Mirth a gay fantastic round:
Loose were her tresses seen, her zone unbound
And he, amidst his frolic play,
As if he would the charming air repay,
Shook thousand odours from his dewy wings.
O Music! sphere-descended maid,
Friend of pleasure, wisdom's aid,
Why, Goddess, why to us denied?
Lay'st thou thy ancient lyre aside?
As in that lov'd Athenian bower,
You learn'd an all-commanding power:
Thy mimic soul, O Nymph endear'd,
Can well recal what then it heard.
Where is thy native simple heart,
Devote to virtue, fancy, art?
Arise, as in that elder time,
Warm, energetic, chaste, sublime!
Thy wonders, in that god-like age,
Fill thy recording sister's page—
'Tis said, and I believe the tale,
Thy humblest reed could more prevail,
Had more of strength, diviner rage,
Than all which charms this laggard age;
Ev'n all at once together found
Cæcilia's mingled world of sound—
O! bid our vain endeavours cease,
Revive the just designs of Greece,
Return in all thy simple state!
Confirm the tales her son's relate.

We shall conclude this section, and these examples, with Gray's *Progress of Poetry*, which, in spite of the severity of Johnson's criticism, certainly ranks high among the odes which pretend to sublimity. The first stanza, when examined by the frigid rules of grammatical criticism, is certainly not faultless; but its faults will be overlooked by every reader who has any portion of the author's fervor:

I. 1.

Awake, Æolian lyre, awake,
And give to rapture all thy trembling strings,
From Helicon's harmonious springs
A thousand rills their mazy progress take:
The laughing flowers, that round them blow,
Drink life and fragrance as they flow.
Now the rich stream of music winds along,
Deep, majestic, smooth, and strong,
Thro' verdant vales, and Ceres' golden reign:
Now rolling down the steep amain,
Headlong, impetuous, see it pour:
The rocks, and nodding groves, rebellow to the roar.

Oh!

I. 2.

Oh! Sovereign of the willing soul,
Parent of sweet and solemn-breathing airs,
Enchanting shell! the fullen cares,
And frantic passions, hear thy soft controul.
On Thracia's hills the lord of war
Has curb'd the fury of his car,
And dropp'd his thirsty lance at thy command.
Perching on the sceptred hand
Of Jove, thy magic lulls the feather'd king
With ruffled plumes, and flagging wing:
Quench'd in dark clouds of slumber lie
The terror of his beak, and lightnings of his eye.

I. 3.

Thee the voice, the dance, obey,
Temper'd to thy warbled lay:
O'er Idalia's velvet-green
The rosy-crowned loves are seen.
On Cytherea's day,
With antic sports, and blue-ey'd pleasures,
Frisking light in frolic measures;
Now pursuing, now retreating,
Now in circling troops they meet;
To brisk notes, in cadence beating,
Glance their many-twinkling feet.
Slow melting strains their queen's approach declare:
Where'er she turns, the graces homage pay.
With arms sublime, that float upon the air,
In gliding state she wins her easy way:
O'er her warm cheek, and rising bosom, move
The bloom of young desire, and purple light of love.

II. 1.

Man's feeble race what ills await;
Labour, and penury, the racks of pain,
Disease, and sorrow's weeping train,
And death, sad refuge from the storms of fate!
The fond complaint, my song, disprove,
And justify the laws of Jove.
Say, has he giv'n in vain the heav'nly muse?
Night, and all her sickly dews,
Her spectres wan, and birds of boding cry,
He gives to range the dreary sky;
Till down the eastern cliffs afar
Hyperion's march they spy, and glitt'ring shafts of war.

II. 2.

In climes beyond the solar road,
Where shaggy forms o'er ice-built mountains roam,
The Muse has broke the twilight-gloom,
To cheer the shiv'ring native's dull abode.
And oft, beneath the od'rous shade
Of Chili's boundless forests laid,
She deigns to hear the savage youth repeat,
In loose numbers wildly sweet,
Their feather-cinctur'd chiefs, and dusky loves.
Her tract, where'er the goddess roves,
Glory pursue, and gen'rous shame,
Th' unconquerable mind, and freedom's holy flame.

II. 3.

Woods, that wave o'er Delphi's steep,
Isles, that crown th' Ægean deep,
Fields, that cool Ilissus laves,
Or where Mæander's amber waves
In ling'ring lab'rins creep,
How do your tuneful echoes languish
Mute, but to the voice of anguish!

Where each old poetic mountain
Inspiration breath'd around;
Ev'ry shade and hallow'd fountain
Murmur'd deep a solemn sound:
Till the sad nine, in Greece's evil hour,
Left their Parnassus for the Latian plains.
Alike they scorn the pomp of tyrant power,
And coward vice that revels in her chains:
When Latium had her lofty spirit lost,
They fought, oh Albion! next thy sea-encircled coast.

III. 1.

Far from the sun, and summer-gale,
In thy green lap was nature's* darling laid,
What time, where lucid Avon stray'd,
To him the mighty mother did unveil
Her awful face: the dauntless child
Stretch'd forth his little arms, and smil'd.
This pencil take (she said) whose colours clear
Richly paint the vernal year:
Thine too these golden keys, immortal boy!
This can unlock the gates of joy;
Of horror that, and thrilling fears,
Or ope the sacred source of sympathetic tears.

III. 2.

Nor second he†, that rode sublime
Upon the seraph-wings of ecstasy,
The secrets of th' abyss to spy.
He pass'd the flaming bounds of place and time:
The living throne, the sapphire blaze,
Where angels tremble while they gaze,
He saw; but, blasted with excess of light,
Clos'd his eyes in endless night.
Behold, where Dryden's less presumptuous car,
Wide o'er the fields of glory bear
Two couriers of ethereal race,
With necks in thunder cloth'd, and long-responding

III. 3.

[pace.]

Hark, his hands the lyre explore!
Bright-ey'd fancy, hov'ring o'er,
Scatters from her pictur'd urn
Thoughts that breathe, and words that burn.
But ah! 'tis heard no more—
Oh! Lyre divine, what daring spirit
Wakes thee now? tho' he inherit
Nor the pride, nor ample pinion,
That the Theban eagle bear,
Sailing with supreme dominion
Through the azure deep of air:
Yet oft before his infant eyes would run
Such forms as glitter in the Muse's ray,
With orient hues, unborrow'd of the sun:
Yet shall he mount, and keep his distant way
Beyond the limits of a vulgar fate,
Beauteous the good how far—but far above the great.

SECT. III. Of the Elegy.

THE *Elegy* is a mournful and plaintive, but yet sweet and engaging, kind of poem. It was first invented to bewail the death of a friend; and afterwards used to express the complaints of lovers, or any other melancholy subject. In process of time, not only matters of grief, but joy, wishes, prayers, expostulations, reproaches, admonitions, and almost every other subject, were admitted into elegy; however, funeral lamentations and affairs of love

Elegy.

love seem most agreeable to its character, which is gentleness and tenuity.

The plaintive elegy, in mournful state,
Dishevell'd weeps the stern decrees of fate :
Now paints the lover's torments and delights ;
Now the nymph flatters, threatens, or invites.
But he, who would these passions well express,
Must more of love than poetry possess.
I hate those lifeless writers whose forc'd fire
In a cold style describes a hot desire ;
Who sigh by rule, and, raging in cold blood,
Their sluggish muse spur to an am'rous mood.
Their ecstasies insipidly they feign ;
And always pine, and fondly hug their chain ;
Adore their prison, and their sull'ring blefs ;
Make sense and reason quarrel as they please.
'Twas not of old in this affected tone,
That smooth Tibullus made his am'rous moan ;
Or tender Ovid, in melodious strains,
Of love's dear art the pleasing rules explains.
You, who in elegy would justly write,
Consult your heart ; let that alone endite.

[From the French of Despreux.] SOAMES.

334
How to be made.

The plan of an elegy, as indeed of all other poems, ought to be made before a line is written ; or else the author will ramble in the dark, and his verses have no dependance on each other. No *epigrammatic points* or conceits, none of those *fine things* which most people are so fond of in every sort of poem, can be allowed in this, but must give place to nobler beauties, those of *nature* and the *passions*. Elegy rejects whatever is facetious, satirical, or majestic, and is content to be plain, decent, and unaffected ; yet in this humble state is the sweet and engaging, elegant and attractive. This poem is adorned with frequent *commiserations*, *complaints*, *exclamations*, *addresses to things or persons*, short and proper *digressions*, *allusions*, *comparisons*, *protopopæias* or feigned persons, and sometimes with short *descriptions*. The diction ought to be free from any *harshness* ; neat, easy, perspicuous, expressive of the manners, tender, and pathetic ; and the numbers should be smooth and flowing, and captivate the ear with their uniform sweetness and delicacy.

Of elegies on the subject of death, that by Mr Gray, written in a country church-yard, is one of the best that has appeared in our language, and may be justly esteemed a masterpiece. But being so generally known, it would be superfluous to insert it here.

On the subject of love, we shall give an example from the elegies of Mr Hammond.

Let others boast their heaps of shining gold,
And view their fields with waving plenty crown'd,
Whom neighb'ring foes in constant terror hold,
And trumpets break their slumbers, never sound :
While, calmly poor, I trifle life away,
Enjoy sweet leisure by my cheerful fire,
No wanton hope my quiet shall betray,
But cheaply blest I'll scorn each vain desire.
With timely care I'll sow my little field,
And plant my orchard with its master's hand ;
Nor blush to spread the hay, the hook to wield,
Or range my sheaves along the sunny land.
If late at dusk, while carelessly I roam,
I meet a strolling kid or bleating lamb,

Elegy.

Under my arm I'll bring the wand'rer home,
And not a little chide its thoughtless dam.
What joy to hear the tempest howl in vain,
And clasp a fearful mistress to my breast ?
Or lull'd to slumber by the beating rain,
Secure and happy sink at last to rest.
Or if the sun in flaming Leo ride,
By shady rivers indolently stray,
And, with my DELIA walking side by side,
Hear how they murmur, as they glide away.
What joy to wind along the cool retreat,
To stop and gaze on DELIA as I go !
To mingle sweet discourse with kisses sweet,
And teach my lovely scholar all I know !
Thus pleas'd at heart, and not with fancy's dream,
In silent happiness I rest unknown ;
Content with what I am, not what I seem,
I live for DELIA and myself alone.

Ah foolish man ! who, thus of her possess'd,
Could float and wander with ambition's wind,
And, if his outward trappings spoke him blest,
Not heed the sickness of his conscious mind.
With her I scorn the idle breath of praise,
Nor trust to happiness that's not our own ;
The smile of fortune might suspicion raise,
But here I know that I am lov'd alone.
STANHOPE, in wisdom as in wit divine,
May rise and plead Britannia's glorious cause,
With steady rein his eager wit confine,
While manly sense the deep attention draws.
Let STANHOPE speak his list'ning country's wrong,
My humble voice shall please one partial maid ;
For her alone I pen my tender song,
Securely sitting in his friendly shade.
STANHOPE shall come, and grace his rural friend ;
DELIA shall wonder at her noble guest,
With blushing awe the riper fruit commend,
And for her husband's patron cull the best.
Her's be the care of all my little train,
While I with tender indolence am blest,
The favourite subject of her gentle reign,
By love alone distinguish'd from the rest.
For her I'll yoke my oxen to the plough,
In gloomy forests tend my lonely flock,
For her a goat-herd climb the mountain's brow,
And sleep extended on the naked rock.
Ah ! what avails to press the stately bed,
And far from her midst tasteless grandeur weep,
By marble fountains lay the pensive head,
And, while they murmur, strive in vain to sleep !
DELIA alone can please and never tire,
Exceed the paint of thought in true delight ;
With her, enjoyment wakens new desire,
And equal rapture glows thro' ev'ry night.
Beauty and worth in her alike contend
To charm the fancy, and to fix the mind ;
In her, my wife, my mistress, and my friend,
I taste the joys of sense and reason join'd.
On her I'll gaze when others loves are o'er,
And dying press her with my clay-cold hand—
Thou weep'st already, as I were no more,
Nor can that gentle breast the thought withstand.
Oh ! when I die, my latest moments spare,
Nor let thy grief with sharper torments kill :
Wound not thy cheeks, nor hurt that flowing hair ;
'Tho' I am dead, my soul shall love thee still.

Oh

Pastoral.

Oh quit the room, oh quit the deathful bed,
Or thou wilt die, so tender is thy heart !
Oh leave me, DELIA! ere thou see me dead,
These weeping friends will do thy mournful part.
Let them, extended on the decent bier,
Convey the corse in melancholy state,
Thro' all the village spread the tender tear,
While pitying maids our wond'rous love relate.

SECT. IV. *Of the Pastoral.*

THIS poem takes its name from the Latin word *pa-*
stor, a "shepherd;" the subject of it being something
in the pastoral or rural life; and the persons, interlocu-
tors, introduced in it, either shepherds or other rustics.

135
The pasto-
ral,

These poems are frequently called *eclogues*, which
signifies "select or choice pieces;" though some ac-
count for this name in a different manner. They are
also called *bucolicks*, from *ΒΥΚΟΛΩ*, "a herdsmen."

136
Why it ge-
nerally
pleases.

This kind of poem, when happily executed, gives
great delight; nor is it a wonder, since innocence and
simplicity generally please: to which let us add, that
the scenes of pastorals are usually laid in the coun-
try, where both poet and painter have abundant mat-
ter for the exercise of genius, such as enchanting pro-
spects, purling streams, shady groves, enamelled meads,
flowery lawns, rural amusements, the bleating of flocks,
and the music of birds; which is of all melody the
most sweet and pleasing, and calls to our mind the wis-
dom and taste of Alexander, who, on being importu-
ned to hear a man that imitated the notes of the
nightingale, and was thought a great curiosity, replied,
that *he had had the happiness of hearing the nightingale her-*
self.

137
Its charac-
ters and

The character of the pastoral consists in simplicity,
brevity, and delicacy; the two first render an eclogue
natural, and the last *delightful*. With respect to na-
ture, indeed, we are to consider, that as a pastoral is an
image of the ancient times of innocence and undesign-
ing plainness, we are not to describe shepherds as they
really are at this day, but as they may be conceived
then to have been, when the best of men, and even
princes, followed the employment. For this reason, an
air of piety should run through the whole poem; which
is visible in the writings of antiquity.

To make it natural with respect to the present age,
some knowledge in rural affairs should be discovered,
and that in such a manner as if it was done by chance
rather than by design; lest by too much pains to seem
natural, that simplicity be destroyed from whence arises
the delight; for what is so engaging in this kind of
poesy proceeds not so much from the idea of a coun-
try life itself, as in exposing only the best part of a
shepherd's life, and concealing the misfortunes and mi-
series which sometimes attend it. Besides, the subject
must contain some particular beauty in itself, and each
eclogue present a scene or prospect to our view enrich-
ed with variety: which variety is in a great measure
obtained by frequent comparisons drawn from the most
agreeable objects of the country; by interrogations to
things inanimate; by short and beautiful digressions;
and by elegant turns on the words, which render the
numbers more sweet and pleasing. To this let us add,
that the connections must be negligent, the narrations
and descriptions short, and the periods concise.

VOL. XV. Part I.

Riddles, parables, proverbs, antique phrases, and su-
perstitious fables, are fit materials to be intermixed with
this kind of poem. They are here, when properly ap-
plied, very ornamental; and the more so, as they give
our modern compositions the air of the ancient manner
of writing.

Pastoral.

138
Style.

The style of the pastoral ought to be humble, yet
pure; neat, but not florid; easy, and yet lively: and
the numbers should be smooth and flowing.

This poem in general should be short, and ought
never much to exceed 100 lines; for we are to consi-
der that the ancients made these sort of compositions
their amusement, and not their business: but however
short they are, every eclogue must contain a plot or
fable, which must be simple and one; but yet so ma-
naged as to admit of short digressions. Virgil has al-
ways observed this.—We shall give the plot or ar-
gument of his first pastoral as an example. *Melibæus,*
an unfortunate shepherd, is introduced with Tityrus, one
in more fortunate circumstances; the former addresses the
complaint of his sufferings and banishment to the latter, who
enjoys his flocks and folds in the midst of the public calamity,
and therefore expresses his gratitude to the benefactor from
whom this favour flowed: but Melibæus accuses fortune,
civil wars, and bids adieu to his native country. This is
therefore a dialogue.

But we are to observe, that the poet is not always
obliged to make his eclogue *allegorical*, and to have real
persons represented by the fictitious characters introdu-
ced; but is in this respect entirely at his own liberty.

Nor does the nature of the poem require it to be al-
ways carried on by way of dialogue; for a shepherd
may with propriety sing the praises of his love, com-
plain of her inconstancy, lament her absence, her death,
&c. and address himself to groves, hills, rivers, and
such like rural objects, even when alone.

We shall now give an example from each of those
authors who have eminently distinguished themselves
by this manner of writing, and introduce them in the
order of time in which they were written.

Theocritus, who was the father or inventor of this
kind of poetry, has been deservedly esteemed by the
best critics; and by some, whose judgment we cannot
dispute, preferred to all other pastoral writers, with
perhaps the single exception of the tender and delicate
Gessner. We shall insert his third *idyllium*, not because
it is the best, but because it is within our compass.

139
Examples
of the pas-
toral from
Theocritus.

To Amaryllis, lovely nymph, I speed,
Meanwhile my goats upon the mountains feed.
O Tityrus, tend them with assiduous care,
Lead them to crystal springs and pastures fair,
And of the ridgling's butting horns beware. }
Sweet Amaryllis, have you then forgot
Our secret pleasures in the conscious grott,
Where in my folding arms you lay reclin'd?
Blest was the shepherd, for the nymph was kind.
I whom you call'd *your Dear, your Love*, so late,
Say, am I now the object of your hate?
Say, is my form displeasing to your sight?
This cruel love will surely kill me quite.
Lo! ten large apples, tempting to the view,
Pluck'd from your favourite tree, where late they grew.
Accept this boon, 'tis all my present store;
To-morrow will produce as many more.

G g

Meanwhile

Pastoral. Meanwhile these heart-consuming pains remove,
And give me gentle pity for my love.
Oh! was I made by some transforming power
A bee to buzz in your sequester'd bow'r!
To pierce your ivy shade with murmuring sound,
And the light leaves that compass you around.
I know thee, Love, and to my sorrow find,
A god thou art, but of the savage kind;
A lioness sure suckled the fell child,
And with his brothers nurs'd him in the wild;
On me his scorching flames incessant prey,
Glow in my bones, and melt my soul away.
Ah, nymph, whose eyes destructive glances dart,
Fair is your face, but flinty is your heart:
With kisses kind this rage of love appease;
For me, fond swain! ev'n empty kisses please.
Your scorn distracts me, and will make me tear
The flow'ry crown I wove for you to wear,
Where roses mingle with the ivy-wreath,
And fragrant herbs ambrosial odours breathe.
Ah me! what pangs I feel; and yet the fair
Nor sees my sorrows nor will hear my pray'r.
I'll doff my garments, since I needs must die,
And from yon rock that points its summit high,
Where patient Alpis snares the finny fry,
I'll leap, and, though perchance I rise again,
You'll laugh to see me plunging in the main.
By a prophetic poppy-leaf I found
Your chang'd affection, for it gave no sound,
Though in my hand struck hollow as it lay,
But quickly wither'd like your love away.
An old witch brought sad tidings to my ears,
She who tells fortunes with the sieve and sheers
For leasing barley in my fields of late,
She told me, I should love, and you should hate!
For you my care a milk-white goat supply'd,
Two wanton kids run frisking at her side;
Which oft the nut-brown maid, Erithacis,
Has begg'd and paid before-hand with a kiss;
And since you thus my ardent passion slight,
Her's they shall be before to-morrow night.
My right eye itches; may it lucky prove,
Perhaps I soon shall see the nymph I love;
Beneath yon pine I'll sing distinct and clear,
Perhaps the fair my tender notes shall hear;
Perhaps may pity my melodious moan;
She is not metamorphos'd into stone.

Hippomenes, provok'd by noble strife,
To win a mistress, or to lose his life,
Threw golden fruit in Atalanta's way:
The bright temptation caus'd the nymph to stay;
She look'd, she languish'd, all her soul took fire,
She plung'd into the gulph of deep desire.

To Pyle from Othrys sage Melampus came,
He drove the lowing herd, yet won the dame;
Fair Pero blest his brother Bias' arms,
And in a virtuous race diffus'd unfading charms.

Adonis fed his cattle on the plain,
And sea-born Venus lov'd the rural swain;
She mourn'd him wounded in the fatal chace,
Nor dead dismiss'd him from her warm embrace.
Though young Endymion was by Cynthia blest,
I envy nothing but his lasting rest.
Jason slumb'ring on the Cretan plain
Ceres once saw, and blest the happy swain
With pleasures too divine for ears profane.

My head grows giddy, love affects me sore;
Yet you regard not; so I'll sing no more —
Here will I put a period to my care —
Adieu, false nymph, adieu ungrateful fair;
Stretch'd near the grotto, when I've breath'd my last,
My corse will give the wolves a rich repast,
As sweet to them as honey to your taste.

FAWKES.

Virgil succeeds Theocritus, from whom he has in some places copied, and always imitated with success. As a specimen of his manner, we shall introduce his first pastoral, which is generally allowed to be the most perfect.

MELIBŒUS and TITYRUS.

140
Virgil

Mel. Beneath the shade which beechen boughs diffuse,
You, Tityrus, entertain your sylvan muse.
Round the wide world in banishment we roam,
For'd from our pleasing fields and native home;
While stretch'd at ease you sing your happy loves,
And Amyrillis fills the shady groves.

Tit. These blessings, friend, a deity bestow'd;
For never can I deem him less than god.
The tender firstlings of my woolly breed
Shall on his holy altar often bleed.

He gave me kine to graze the flow'ry plain,
And so my pipe renew'd the rural strain.

Mel. I envy not your fortune; but admire,
That while the raging sword and wasteful fire
Destroy the wretched neighbourhood around,
No hostile arms approach your happy ground.
Far diff'rent is my fate; my feeble goats
With pains I drive from their forsaken cotes:
And this you see I scarcely drag along,
Who yearning on the rocks has left her young,
The hope and promise of my falling fold,
My loss by dire portents the gods foretold;
For, had I not been blind, I might have seen
Yon riven oak, the fairest on the green,
And the hoarse raven on the blasted bough
By croaking from the left presag'd the coming blow.
But tell me, Tityrus, what heav'nly pow'r
Preserv'd your fortunes in that fatal hour?

Tit. Fool that I was, I thought imperial Rome
Like Mantua, where on market-days we come,
And thither drive our tender lambs from home.
So kids and whelps their fires and dams express;
And so the great I measur'd by the less:
But country-towns, compar'd with her, appear
Like shrubs when lofty cypresses are near.

Mel. What great occasion call'd you hence to Rome?

Tit. Freedom, which came at length, tho' slow to come:
Nor did my search of liberty begin
Till my black hairs were chang'd upon my chin;
Nor Amaryllis would vouchsafe a look,
Till Galatea's meaner bonds I broke.
Till then a helpless, hopeless, homely swain,
I sought not freedom, nor aspir'd to gain:
Tho' many a victim from my folds was bought,
And many a cheese to country markets brought,
Yet all the little that I got I spent,
And still return'd as empty as I went.

Mel. We stood amaz'd to see your mistress mourn,
Unknowing that she pin'd for your return;
We wonder'd why she kept her fruit so long,
For whom so late th' ungather'd apples hung:

But

Pastoral.

But now the wonder ceases, since I see
She kept them only, Tityrus, for thee :
For thee the bubbling springs appear'd to mourn,
And whisp'ring pines made vows for thy return.

Tit. What should I do ? while here I was enchain'd,
No glimpse of godlike liberty remain'd ;
Nor could I hope in any place but there
To find a god so present to my pray'r.
There first the youth of heav'nly birth I view'd,
For whom our monthly victims are renew'd.
He heard my vows, and graciously decreed
My grounds to be restor'd my former flocks to feed.

Mel. O fortunate old man ! whose farm remains
For you sufficient, and requites your pains,
Though rushes overspread the neighb'ring plains,
Tho' here the marshy grounds approach your fields,
And there the soil a stony harvest yields.
Your teeming ewes shall no strange meadows try,
Nor fear a rot from tainted company.
Behold yon bord'ring fence of fallow trees [bees :
Is fraught with flow'rs, the flow'rs are fraught with
The busy bees, with a soft murm'ring strain,
Invite to gentle sleep the lab'ring swain :
While from the neighb'ring rock with rural songs
The pruner's voice the pleasing dream prolongs ;
Stock-doves and turtles tell their am'rous pain,
And, from the lofty elms, of love complain.

Tit. Th' inhabitants of seas and skies shall change,
And fish on shore and stags in air shall range,
The banish'd Parthian dwell on Arar's brink,
And the blue German shall the Tigris drink ;
Ere I, forsaking gratitude and truth,
Forget the figure of that godlike youth.

Mel. But we must beg our bread in climes unknown,
Beneath the scorching or the freezing zone ;
And some to fair Oaxis shall be sold,
Or try the Libyan heat or Scythian cold ;
The rest among the Britons be confin'd,
A race of men from all the world disjoin'd.
O ! must the wretched exiles ever mourn ?
Nor after length of rolling years return ?
Are we condemn'd by Fate's unjust decree,
No more our houses and our homes to see ?
Or shall we mount again the rural throne,
And rule the country, kingdoms once our own ?
Did we for these barbarians plant and sow,
On these, on these, our happy fields bestow ?
Good heav'n, what dire effects from civil discord flow !
Now let me graft my pears, and prune the vine ;
The fruit is theirs, the labour only mine.
Farewel my pastures, my paternal stock !
My fruitful fields, and my more fruitful flock !
No more, my goats, shall I behold you climb
The steepy cliffs, or crop the flow'ry thyme ;
No more extended in the grot below,
Shall see you browsing on the mountain's brow
The prickly shrubs, and after on the bare
Lean down the deep abyfs and hang in air !
No more my sheep shall sip the morning dew ;
No more my song shall please the rural crew :
Adieu, my tuneful pipe ! and all the world, adieu !

Tit. This night, at least, with me forget your care ;
Chefnuts and curds and cream shall be your fare :
The carpet-ground shall be with leaves o'er-spread,
And boughs shall weave a cov'ring for your head :

For see yon sunny hill the shade extends,
And curling smoke from cottages ascends.

DRYDEN.

Spenser was the first of our countrymen who acquired any considerable reputation by this method of writing. We shall insert his sixth eclogue, or that for June, which is allegorical, as will be seen by the

ARGUMENT. "Hobbinol, from a description of the pleasures of the place, excites Colin to the enjoyment of them. Colin declares himself incapable of delight, by reason of his ill success in love, and his loss of Rosalind, who had treacherously forsaken him for Menalcas another shepherd. By Tityrus (mentioned before in Spenser's second eclogue, and again in the twelfth) is plainly meant Chaucer, whom the author sometimes professed to imitate. In the person of Colin is represented the author himself ; and Hobbinol's inviting him to leave the hill country, seems to allude to his leaving the North, where, as is mentioned in his life, he had for some time resided."

Hob. Lo ! Colin, here the place, whose pleasant sight
From other shades hath wean'd my wand'ring mind :

Tell me, what wants me here, to work delight ?

The simple air, the gentle warbling wind,
So calm, so cool, as nowhere else I find :
The grassy ground with dainty daisies dight,
The bramble-bush, where birds of every kind
To th' water's fall their tunes attempt right.

Col. O ! happy Hobbinol, I blest thy state,
That paradise hast found which Adam lost.

Here wander may thy flock early or late,
Withouten dread of wolves to been ytoft ;

Thy lovely lays here mayst thou freely boast :
But I, unhappy man ! whom cruel fate,
And angry gods, pursue from coast to coast,
Can nowhere find to shroud my luckless pate.

Hob. Then if by me thou list advised be,
Forsake the soil that so doth thee bewitch :

Leave me those hills, where harbroughnis to see,
Nor holly-bush, nor breere, nor winding ditch ;
And to the dales resort, where shepherds rich,
And fruitful flocks been everywhere to see :

Here no night-ravens lodge, more black than pitch,
Nor elvish ghossts, nor ghastly owls do see.

But friendly fairies met with many graces,
And light-foot nymphs can chace the ling ring night,
With heydegues, and trimly trodden traces ;

Whilst sisters nine, which dwell on Parnass' height,
Do make them music, for their more delight ;
And Pan himself to kiss their crystal faces,

Will pipe and dance, when Phoebe shineth bright :
Such peerless pleasures have we in these places.

Col. And I whilst youth, and course of careless years,
Did let me walk withouten links of love,

In such delights did joy amongst my peers :
But riper age such pleasures doth reprove,

My fancy eke from former follies move
To strayed steps : for time in passing wears
(As garments doen, which waxen old above)

And draweth new delights with hoary hairs.
Though conth I sing of love, and tune my pipe
Unto my plantive pleas in verses made :

Though would I seek for queen-apples unripe
To give my Rosalind, and in sommer shade

G g 2

Dight

r48
Spenser.

Pastoral.

Dight gawdy girlonds was my common trade,
To crown her golden locks: but years more ripe,
And loss of her, whose love as life I wayde,
Those weary wanton toys away did wipe.

Hob. Colin, to hear thy rhymes and roundelays,
Which thou wert wont on wasteful hills to sing,
I more delight, than lark in sommer days:
Whose echo made the neighbour groves to ring,
And taught the birds, which in the lower spring
Did shroud in shady leaves from sunny rays,
Frame to thy song their cheerful cherishing,
Or hold their peace, for shame of thy sweet lays.

I saw Calliope with muses moe,
Soon as thy oaten pipe began to found,
Their ivory lutes and tamburins forego,
And from the fountain, where they fate around,
Ren after hastily thy silver sound.
But when they came, where thou thy skill didst show,
They drew aback, as half with shame confound,
Shepherd to see, them in their art out-go.

Col. Of muses, Hobbinol, I can no skill,
For they been daughters of the highest Jove,
And holden scorn of homely shepherds quill:
For sith I heard that Pan with Phœbus strove
Which him to much rebuke and danger drove,
I never list presume to Parnass' hill,
But piping low, in shade of lowly grove,
I play to please myself, albeit ill.

Nought weigh I, who my song doth praise or blame,
Ne strive to win renown, or pass the rest:

With shepherds fits not follow flying fame,
But feed his flocks in fields, where falls him best.

I wot my rimes been rough, and rudely drest;
The fitter they, my careful case to frame:
Enough is me to paint out my unrest,
And pour my piteous complaints out in the fame.

The God of shepherds, Tityrus, is dead,
Who taught me homely, as I can, to make:
He, whilst he liv'd, was the sovereign head
Of shepherds all, that been with love ytake.

Well couth he wail his woes, and lightly shake
The flames which love within his heart had bred,
And tell us merry tales to keep us wake,
The while our sheep about us safely fed.

Now dead he is, and lieth wrapt in lead,
(O why should death on him such outrage show!)

And all his passing skill with him is fled,
The fame whereof doth daily greater grow.

But if on me some little drops would flow
Of that the spring was in his learned hed,
I soon would learn these woods to wail my woe,
And teach the trees their trickling tears to shed.

Then should my complaints, caus'd of discourteese,
As messengers of this my painful flight,
Fly to my love, wherever that she be,

And pierce her heart with point of worthy wight;
As she deserves, that wrought so deadly sight.
And thou, Menalcas, that by treachery

Didst underfong my lads to wax so light,
Should'st well be known for such thy villany.

But since I am not, as I wish I were,
Ye gentle shepherds, which your flocks do feed,
Whether on hills or dales, or other where,
Bear witness all of this so wicked deed:

And tell the lads, whose flower is woxe a weed,

And faultless faith is turn'd to faithless seere;
That she the truest shepherd's heart made bleed,
That lives on earth, and loved her most dear.

Hob. O! careful Colin, I lament thy case,
Thy tears would make the hardest flint to flow!
Ah! faithless Rosalind, and void of grace,
That art the root of all this rueful woe!

But now is time, I guess, homeward to go;
Then rise, ye blessed flocks, and home apace,
Lest night with stealing steps do you foreflood,
And wet your tender lambs that by you trace.

By the following eclogue the reader will perceive that
Mr Philips has, in imitation of Spenser, preserved in his
pastorals many antiquated words, which, though they are
discarded from polite conversation, may naturally be sup-
posed still to have place among the shepherds and other
rustics in the country. We have made choice of his se-
cond eclogue, because it is brought home to his own bu-
siness, and contains a complaint against those who had
spoken ill of him and his writings.

THENOT, COLINET.

142
Philips

Th. Is it not Colinet I lonesome see
Leaning with folded arms against the tree?
Or is it age of late bedims my sight?
'Tis Colinet, indeed, in woful plight.

Thy cloudy look, why melting into tears,
Unseenly, now the sky so bright appears?
Why in this mournful manner art thou found,
Unthankful lad, when all things smile around?
Or hear'st not lark and linnet jointly sing,
Their notes blithe-warbling to salute the spring?

Co. Tho' blithe their notes, not so my wayward fate;
Nor lark would sing, nor linnet, in my state.
Each creature, Thenot, to his task is born;
As they to mirth and music, I to mourn.
Waking, at midnight, I my woes renew,
My tears oft mingling with the falling dew.

Th. Small cause, I ween, has lusty youth to plain;
Or who may then the weight of eld sustain,
When every slackening nerve begins to fail,
And the load presseth as our days prevail?
Yet though with years my body downward tend,
As trees beneath their fruit in autumn bend,
Spite of my snowy head and icy veins,
My mind a cheerful temper still retains:
And why should man, mishap what will, repine,
Sour every sweet, and mix with tears his wine?
But tell me then; it may relieve thy woe,
To let a friend thine inward ailment know.

Co. Idly 'twill waste thee, Thenot, the whole day,
Should'st thou give ear to all my grief can say,
Thine ewes will wander; and the heedless lambs,
In loud complaints, require their absent dams.

Th. See Lightfoot; he shall tend them close: and I,
'Tween whiles, across the plain will glance mine eye.

Co. Where to begin I know not, where to end.
Does there one smiling hour my youth attend?
Though few my days, as well my follies show,
Yet are those days all clouded o'er with wo:
No happy gleam of sunshine doth appear,
My lowering sky and wint'ry months to cheer.
My piteous plight in yonder naked tree,
Which bears the thunder-scar too plain, I see:
Quite destitute it stands of shelter kind,
The mark of storms, and sport of every wind:

The

Pastoral.

The riven trunk feels not the approach of spring ;
Nor birds among the leafless branches sing :
No more, beneath thy shade, shall shepherds throng
With jocund tale, or pipe, or pleasing song.
Ill-fated tree ! and more ill-fated I !
From thee, from me, alike the shepherds fly.

Tb. Sure thou in hapless hour of time wast born,
When blighting mildews spoil the rising corn,
Or blating winds o'er blossom'd hedge-rows pass,
To kill the promis'd fruits, and scorch the grass ;
Or when the moon, by wizard charm'd, foreshows,
Blood-stain'd in foul eclipse, impending woes.
Untimely born, ill luck betides thee still.

Co. And can there, Thenot, be a greater ill ?

Tb. Nor fox, nor wolf, nor rot among our sheep :
From these good shepherd's care his flock may keep :
Against ill luck, alas ! all forecast fails ;
Nor toil by day, nor watch by night, avails.

Co. Ah me, the while ! ah me, the luckless day !
Ah luckless lad ! befits me more to say.

Unhappy hour ! when fresh in youthful bud,
I left, Sabrina fair, thy silv'ry flood.
Ah silly I ! more silly than my sheep,
Which on thy flow'ry banks I wont to keep.
Sweet are thy banks ; oh, when shall I once more
With ravish'd eyes review thine amell'd shore ?
When, in the crystal of thy waters, scan
Each feature faded, and my colour wan ?
When shall I see my hut, the small abode
Myself did raise and cover o'er with sod ?
Small though it be, a mean and humble cell,
Yet is there room for peace and me to dwell.

Tb. And what enticement charm'd thee far away
From thy lov'd home, and led thy heart astray ?

Co. A lewd desire strange lands and swains to know.
Ah me ! that ever I should covet wo.
With wand'ring feet unblest, and fond of fame,
I sought I know not what besides a name.

Tb. Or, sooth to say, didst thou not hither come
In search of gains more plenty than at home ?
A rolling stone is ever bare of moss ;
And, to their cost, green years old proverbs cross.

Co. Small need there was, in random search of gain,
To drive my pining flock athwart the plain
To distant Cam. Fine gain at length, I trow,
To hoard up to myself such deal of wo !
My sheep quite spent through travel and ill fare,
And like their keeper ragged grown and bare,
The damp cold green sward for my nightly bed,
And some flaunt willow's trunk to rest my head.
Hard is to bear of pinching cold the pain ;
And hard is want to the unpractis'd swain ;
But neither want, nor pinching cold, is hard,
To blasting storms of calumny compar'd :
Unkind as hail it falls ; the pelting show'r
Destroys the tender herb and budding flow'r.

Tb. Slander we shepherds count the vilest wrong :
And what wounds forer than an evil tongue ?

Co. Untoward lads, the wanton imps of spite
Make mock of all the ditties I endite.
In vain, O Colinet, thy pipe, so shrill,
Charms every vale, and gladdens every hill :
In vain thou seek'st the coverings of the grove,
In the cool shade to sing the pains of love :

Sing what thou wilt, ill-nature will prevail ;
And every elf hath skill enough to rail.
But yet, though poor and artless be my vein,
Menalcas seems to like my simple strain :
And while that he delighteth in my song,
Which to the good Menalcas doth belong,
Nor night nor day shall my rude music cease ;
I ask no more, so I Menalcas please.

Tb. Menalcas, lord of these fair fertile plains,
Preserves the sheep, and o'er the shepherds reigns :
For him our yearly wakes and feasts we hold,
And choose the fairest firstlings from the fold ;
He, good to all who good deserves, shall give
Thy flock to feed, and thee at ease to live,
Shall curb the malice of unbridled tongues,
And bounteously reward thy rural songs.

Co. First then shall lightsome birds forget to fly,
The briny ocean turn to pastures dry,
And every rapid river cease to flow,
Ere I unmindful of Menalcas grow.

Tb. This night thy care with me forget, and fold
Thy flock with mine, to ward th' injurious cold.
New milk, and clouted cream, mild cheese and curd,
With some remaining fruit of last year's hoard,
Shall be our ev'ning fare ; and, for the night,
Sweet herbs and moss, which gentle sleep invite :
And now behold the sun's departing ray,
O'er yonder hill, the sign of ebbing day :
With songs the jovial hinds return from plow ;
And unyok'd heifers, loitering homeward, low.

Mr Pope's Pastorals next appeared, but in a different dress from those of Spenser and Philips ; for he has discarded all antiquated words, drawn his swains more modern and polite, and made his numbers exquisitely harmonious : his eclogues therefore may be called *better poems*, but not *better pastorals*. We shall insert the eclogue he has inscribed to Mr Wycherly, the beginning of which is in imitation of Virgil's first pastoral.

Beneath the shade a spreading beech displays,
Hylas and Ægon sung their rural lays :
This mourn'd a faithless, that an absent love,
And Delia's name and Doris fill'd the grove.
Ye Mantuan nymphs, your sacred succour bring ;
Hylas and Ægon's rural lays I sing.

Thou, whom the nine with Plautus' wit inspire,
The art of Terence, and Menander's fire :
Whose sense instructs us, and whose humour charms,
Whose judgment sways us, and whose spirit warms !
Oh, skill'd in nature ! see the hearts of swains,
Their artless passions, and their tender pains.

Now setting Phœbus shone serenely bright,
And fleecy clouds were streak'd with purple light ;
When tuneful Hylas, with melodious moan,
Taught rocks to weep, and made the mountains groan.

Go, gentle gales, and bear my sighs away !
To Delia's ear the tender notes convey.
As some sad turtle his lost love deplores,
And with deep murmurs fills the sounding shores ;
Thus, far from Delia, to the winds I mourn,
Alike unheard, un pity'd, and forlorn.

Go, gentle gales, and bear my sighs along !
For her the feather'd quires neglect their song ;
For her, the limes their pleasing shades deny ;
For her, the lilies hang their head and die.

Pastoral.

Ye flow'rs, that droop, forsaken by the spring;
Ye birds, that left by summer cease to sing;
Ye trees, that fade when autumn-heats remove;
Say, is not absence death to those who love?

Go, gentle gales, and bear my sighs away!
Curs'd be the fields that cause my Delia's stay:
Fade ev'ry blossom, wither ev'ry tree,
Die ev'ry flow'r and perish all but she.
What have I said? where'er my Delia flies,
Let spring attend, and sudden flow'rs arise;
Let opening roses knotted oaks adorn,
And liquid amber drop from ev'ry thorn.

Go, gentle gales, and bear my sighs along!
The birds shall cease to tune their ev'ning song,
The winds to breathe, the waving woods to move,
And streams to murmur, ere I cease to love.
Not bubbling fountains to the thirsty swain,
Not balmy sleep to lab'ers faint with pain,
Not show'rs to larks, or sunshine to the bee,
Are half so charming as thy sight to me.

Go, gentle gales, and bear my sighs away!
Come, Delia, come! ah, why this long delay?
Through rocks and caves the name of Delia sounds;
Delia, each cave and echoing rock rebounds.
Ye pow'rs, what pleasing frenzy sooths my mind!
Do lovers dream, or is my Delia kind?
She comes, my Delia comes!—now cease, my lay;
And cease, ye gales to bear my sighs away!

Next Ægon sung, while Windsor groves admir'd;
Rehearse, ye muses, what yourselves inspir'd.

Resound, ye hills, resound my mournful strain!
Of perjur'd Doris, dying, I complain:
Here where the mountains, less'ning as they rise,
Lose the low vales, and steal into the skies;
While lab'ring oxen, spent with toil and heat,
In their loose traces from the field retreat;
While curling smokes from village-tops are seen,
And the fleet shades glide o'er the dusky green.

Resound, ye hills, resound my mournful lay!
Beneath yon poplar oft we pass'd the day:
Oft on the rind I carv'd her am'rous vows,
While she with garlands hung the bending boughs:
The garlands fade, the boughs are worn away;
So dies her love, and so my hopes decay.

Resound, ye hills, resound my mournful strain!
Now bright Arcturus glads the teeming grain;
Now golden fruits in loaded branches shine,
And grateful clusters, swell with floods of wine;
Now blushing berries paint the yellow grove:
Just Gods! shall all things yield returns but love?

Resound, ye hills, resound my mournful lay!
The shepherds cry, "Thy flocks are left a prey."——
Ah! what avails it me the flocks to keep,
Who lost my heart, while I preserv'd my sheep?
Pan came, and ask'd, what magic caus'd my sinart,
Or what ill eyes malignant glances dart?
What eyes but hers, alas! have pow'r to move?
And is there magic but what dwells in love?

Resound, ye hills, resound my mournful strains!
I'll fly from shepherds, flocks, and flow'ry plains.——
From shepherds, flocks, and plains, I may remove,
For sake mankind, and all the world—but love!
I know thee, Love! wild as the raging main,
More fell than tygers on the Libyan plain:

Thou wert from Ætna's burning entrails torn,
Got by fierce whirlwinds, and in thunder born.

Resound, ye hills, resound my mournful lay!
Farewel, ye woods, adieu the light of day!
One leap from yonder cliff shall end my pains.
No more, ye hills, no more resound my strains!

Thus sung the shepherds till th' approach of night,
The skies yet blushing with departing light,
When falling dews with spangles deck'd the glade,
And the low sun had lengthen'd ev'ry shade.

To these pastorals, which are written agreeably to the taste of antiquity, and the rules above prescribed, we shall beg leave to subjoin another that may be called *burlesque pastoral*, wherein the ingenious author, Mr Gay, has ventured to deviate from the beaten road, and described the shepherds and ploughmen of our own time and country, instead of those of the golden age, to which the modern critics confine the pastoral. His six pastorals, which he calls the *Shepherd's Week*, are a beautiful and lively representation of the manners, customs, and notions of our rustics. We shall insert the first of them, intitled *The Squalble*, wherein two clowns try to outdo each other in singing the praises of their sweethearts, leaving it to a third to determine the controversy. The persons named are *Lobbin Clout*, *Cuddy*, and *Cloddipole*.

Lob. Thy younglings, Cuddy, are but just awake;
No thrortle shrill the bramble-bush forsake;
No chirping lark the welkin sheen * invokes;
No damsel yet the swelling udder strokes;
O'er yonder hill does scant † the dawn appear;
Then why does Cuddy leave his cott so rear ‡?

Cud. Ah Lobbin Clout! I ween || my plight is guest;
For he that loves, a stranger is to rest.

If swains belye not, thou hast prov'd the smart,
And Blouzalinda's mistress of thy heart.
This rising tear betokeneth well thy mind;
Those arms are folded for thy Blouzalind.
And well, I trow, our piteous plights agree;
Thee Blouzalinda smites, Buxoma me.

Lob. Ah Blouzalind! I love thee more by half,
Than deer their fawns, or cows the new-fall'n calf.
Woe worth the tongue, may blisters fore it gall,
That names *Buxoma Blouzalind* withal!

Cud. Hold, witless Lobbin Clout, I thee advise,
Lest blisters sore on thy own tongue arise.
Lo yonder Cloddipole, the blithsome swain,
The wisest lout of all the neighb'ring plain!
From Cloddipole we learnt to read the skies,
To know when hail will fall or winds arise.
He taught us erst * the heifer's tail to view,
When stuck aloft, that show'rs would straight ensue:
He first that useful secret did explain,
That pricking corns foretold the gath'ring rain.
When swallows fleet soar high and sport in air,
He told us that the welkin would be clear.
Let Cloddipole then hear us twain rehearse,
And praise his sweetheart in alternate verse.
I'll wager this same oaken staff with thee,
That Cloddipole shall give the prize to me.

Lob. See this tobacco-pouch, that's lin'd with hair,
Made of the skin of sleekest fallow-deer:
This pouch, that's tied with tape of reddest hue,
I'll wager, that the prize shall be my due.

144
Gay.* Shining
or bright
sky.

† Scarce.

‡ Early.

|| Conceive.

• Former!

Pastoral.

Pastoral.

Cud. Begin thy carrols, then, thou vaunting slouch;
Be thine the oaken staff, or mine the pouch.

Lob. My Blouzalinda is the blithest lass,
Than primrose sweeter, or the clover-grass.
Fair is the king-cup that in meadow blows,
Fair is the daisy that beside her grows;
Fair is the gilly-flow'r of gardens sweet;
Fair is the marygold, for pottage meet:
But Blouzalind's than gilly-flow'r more fair,
Than daisy, marygold, or king-cup rare.

Cud. My brown Buxoma is the featest maid
That e'er at wake delightfome gambol play'd;
Clean as young lambkins, or the goose's down,
And like the goldfinch in her Sunday gown.
The wilefs lamb may sport upon the plain,
The frisking kid delight the gaping swain;
The wanton calf may skip with many a bound,
And my cur Tray play deffest † feats around:
But neither lamb, nor kid, nor calf, nor Tray,
Dance like Buxoma on the first of May.

Nimblest.

Lob. Sweet is my toil when Blouzalind is near;
Of her bereft, 'tis winter all the year.

With her no sultry summer's heat I know;
In winter, when she's nigh, with love I glow.
Come, Blouzalinda, ease thy swain's desire,
My summer's shadow, and my winter's fire!

† Very bon.

Cud. As with Buxoma once I work'd at hay,
E'en noon-tide labour seem'd an holiday;
And holidays, if haply she were gone,
Like worky-days I wish'd would soon be done.
Eftsoons †, O sweetheart kind, my love repay,
And all the year shall then be holiday.

Lob. As Blouzalinda, in a gamesome mood,
Behind a hay-cock loudly laughing stood,
I sily ran and snatch'd a hasty kiss;
She wip'd her lips, nor took it much amiss.
Believe me, Cuddy, while I'm bold to say,
Her breath was sweeter than the ripen'd hay.

‡ Wag-gishly.

Cud. As my Buxoma, in a morning fair,
With gentle finger stroak'd her milky care,
I quaintly ‡ stole a kiss; at first, 'tis true,
She frown'd, yet after granted one or two.
Lobbin, I swear, believe who will my vows,
Her breath by far excell'd the breathing cows.

Lob. Leek to the Welch, to Dutchemen butter's dear,
Of Irish swains potatoes are the cheer;
Oats for their feasts the Scottish shepherds grind,
Sweet turnips are the food of Blouzalind:
While she loves turnips, butter I'll despise,
Nor leeks, nor oatmeal, nor potatoes prize.

Cud. In good roast beef my landlord sticks his knife,
The capon fat delights his dainty wife;
Pudding our parson eats, the squire loves hare;
But white-pot thick is my Buxoma's fare.
While she loves white-pot, capon ne'er shall be,
Nor hare, nor beef, nor pudding, food for me.

Lob. As once I play'd at blind man's buff, it hapt
About my eyes the towel thick was wrapt:
I miss'd the swains, and seiz'd on Blouzalind;
True speaks that ancient proverb, Love is blind.

Cud. As at hot-cockles once I laid me down,
And felt the weighty hand of many a clown;
Buxoma gave a gentle tap, and I
Quick rose, and read soft mischief in her eye.

Lob. On two near elms the slacken'd cord I hung;
Now high, now low, my Blouzalinda swung;

With the rude wind her rumpled garment rose,
And show'd her taper leg and scarlet hose.

Cud. Across the fallen oak the plank I laid,
And myself pois'd against the tott'ring maid!
High leapt the plank, and down Buxoma fell;
I spy'd—but faithful sweethearts never tell.

Lob. This riddle, Cuddy, if thou canst, explain,
This wily riddle puzzles every swain:

*What flow'r is that which bears the virgin's name,
The richest metal joined with the same * ?*

* Mary-gold.

Cud. Answer, thou carle, and judge this riddle right,
I'll frankly own thee for a cunning wight:

*What flow'r is that which royal honour craves,
Adjoin the virgin, and 'tis strown on graves † ?*

† Rose-mary.

Cud. Forbear, contending louts, give o'er your strains;
An oaken staff each merits for his pains.
But see the sun-beams bright to labour warn,
And gild the thatch of goodman Hodge's barn.
Your herds for want of water stand a-dry;
They're weary of your songs—and so am I.

We have given the rules usually laid down for pastoral writing, and exhibited some examples written on this plan; but we have to observe, that this poem may take very different forms. It may appear either as a comedy or as a ballad. As a pastoral comedy, there is perhaps nothing which possesses equal merit with Ramsay's *Gentle Shepherd*, and we know not where to find in any language a rival to the *Pastoral Ballad* of Shenstone. That the excellence of this poem is great can hardly be questioned, since it compelled a critic, who was never lavish of his praise, and who on all occasions was ready to vilify the pastoral, to express himself in terms of high encomium. "In the first part (says he) are two passages, to which if any mind denies its sympathy, it has no acquaintance with love or nature:

145
Shenstone,

I priz'd every hour that went by,

Beyond all that had pleas'd me before;

But now they are past, and I sigh,

And I grieve that I priz'd them no more.

When forc'd the fair nymph to forego,

What anguish I felt in my heart!

Yet I thought—but it might not be so,

'Twas with pain that she saw me depart.

She gaz'd, as I slowly withdrew,

My path I could hardly discern;

So sweetly she bade me adieu,

I thought that she bade me return.

"In the second (continues the same critic) this passage has its prettiness, though it be not equal to the former:"

I have found out a gift for my fair;

I have found where the wood-pigeons breed;

But let me that plunder forbear,

She would say 'twas a barbarous deed:

For he ne'er could be true, she averr'd,

Who could rob a poor bird of its young;

And I lov'd her the more when I heard

Such tenderness fall from her tongue.

SECT. V. Of Didactic or Preceptive Poetry.

146

THE method of writing precepts in verse, and embellishing them with the graces of poetry, had its rise, we may suppose, from a due consideration of the frailties

Origin and use of didactic poetry.

Didactic. ties and perverseness of human nature; and was intended to engage the affections, in order to improve the mind and amend the heart.

Didactic or preceptive poetry, has been usually employed either to illustrate and explain our moral duties, our philosophical inquiries, our business and pleasures; or in teaching the art of criticism or poetry itself. It may be adapted, however, to any other subject; and may in all cases, where instruction is designed, be employed to good purpose. Some subjects, indeed, are more proper than others, as they admit of more poetical ornaments, and give a greater latitude to genius: but whatever the subject is, those precepts are to be laid down that are the most useful; and they should follow each other in a natural easy method, and be delivered in the most agreeable engaging manner. What the prose writer tells you ought to be done, the poet often conveys under the form of a narration, or shows the necessity of in a description; and by representing the action as done, or doing, conceals the precept that should enforce it. The poet likewise, instead of telling the whole truth, or laying down all the rules that are requisite, selects such parts only as are the most pleasing, and communicates the rest indirectly, without giving us an open view of them; yet takes care that nothing shall escape the reader's notice with which he ought to be acquainted. He discloses just enough to lead the imagination into the parts that are concealed; and the mind, ever gratified with its own discoveries, is complimented with exploring and finding them out; which, though done with ease, seems so considerable, as not to be obtained but in consequence of its own adroitness and sagacity.

147
Rules to be
observed in
the compo-
sition.

But this is not sufficient to render didactic poetry always pleasing: for where precepts are laid down one after another, and the poem is of considerable length, the mind will require some recreation and refreshment by the way; which is to be procured by seasonable moral reflections, pertinent remarks, familiar similes, and descriptions naturally introduced, by allusions to ancient histories or fables, and by short and pleasant digressions and excursions into more noble subjects, so aptly brought in, that they may seem to have a remote relation, and be of a piece with the poem. By thus varying the form of instruction, the poet gives life to his precepts, and awakens and secures our attention, without permitting us to see by what means we are thus captivated: and his art is the more to be admired, because it is so concealed as to escape the reader's observation.

The style, too, must maintain a dignity suitable to the subject, and every part be drawn in such lively colours, that the things described may seem as if presented to the reader's view.

But all this will appear more evident from example; and though entire poems of this kind are not within the compass of our design, we shall endeavour to select such passages as will be sufficient to illustrate the rules we have here laid down.

We have already observed, that, according to the usual divisions, there are four kinds of didactic poems, viz. those that respect our moral duties, our philosophical speculations, our business and pleasures, or that give precepts for poetry and criticism.

I. On the first subject, indeed, we have scarce any thing

that deserves the name of poetry, except Mr Pope's *Didactic. Essay on Man*, his *Ethic Epistles*, Blackmore's *Creation*, and part of Young's *Night Thoughts*; to which therefore we refer as examples.

II. Those preceptive poems that concern philosophical speculations, though the subject is so pregnant with matter, affords such a field for fancy, and is so capable of every decoration, are but few. Lucretius is the most considerable among the ancients who has written in this manner; among the moderns we have little else but small detached pieces, except the poem called *Anti-Lucretius*, which has not yet received an English dress; Dr Akenfide's *Pleasures of the Imagination*, and Dr Darwin's *Botanic Garden*; which are all worthy of our admiration. Some of the small pieces in this department are also well executed; and there is one entitled the *Universe*, written by Mr Baker, from which we shall borrow an example.

The author's scheme is in some measure coincident with Mr Pope's, so far especially as it tends to restrain the pride of man, with which design it was professedly written.

The passage we have selected is that respecting the planetary system.

Unwise! and thoughtless! impotent! and blind!
Can wealth, or grandeur, satisfy the mind?
Of all those pleasures mortals most admire,
Is there one joy sincere, that will not tire?
Can love itself endure? or beauty's charms
Afford that bliss we fancy in its arms?—
Then, let thy soul more glorious aims pursue:
Have thy CREATOR and his works in view.
Be these thy study: hence thy pleasures bring:
And drink large draughts of wisdom from its spring;
That spring, whence perfect joy, and calm repose,
And blest content, and peace eternal, flows.

Observe how regular the planets run,
In stated times, their courses round the Sun.
Diff'rent their bulk, their distance, their career,
And diff'rent much the compass of their year:
Yet all the same eternal laws obey,
While God's unerring finger points the way.

First Mercury, amidst full tides of light,
Rolls next the sun, through his small circle bright.
All that dwell here must be refin'd and pure:
Bodies like ours such ardour can't endure:
Our earth would blaze beneath so fierce a ray,
And all its marble mountains melt away.

Fair Venus, next, fulfils her larger round,
With softer beams, and milder glory crown'd.
Friend to mankind, she glitters from afar,
Now the bright evening, now the morning star.

More distant still, our earth comes rolling on,
And forms a wider circle round the sun:
With her the moon, companion ever dear!
Her course attending through the shining year.

See, Mars, alone, runs his appointed race,
And measures out, exact, the destin'd space:
Nor nearer does he wind, nor farther stray,
But finds the point whence first he roll'd away.

More yet remote from day's all-cheering source,
Vast Jupiter performs his constant course:
Four friendly moons, with borrow'd lustre, rise,
Bestow their beams divine, and light his skies.

Farthest and last, scarce warm'd by Phœbus' ray,
Through his vast orbit Saturn wheels away.

148
Examples
in didactic
poetry.

How

Didactic. How great the change could we be waded there!
 How slow the seasons! and how long the year!
 One moon, on us, reflects its cheerful light:
 There, five attendants brighten up the night.
 Here, the blue firmament bedeck'd with stars;
 There, over-head, a lucid arch appears.
 From hence, how large, how strong, the sun's bright ball!
 But seen from thence, how languid and how small! —
 When the keen north with all its fury blows,
 Congeals the floods, and forms the fleecy snows,
 'Tis heat intense to what can there be known:
 Warmer our poles than is its burning zone.

Who there inhabit must have other pow'rs,
 Juices, and veins, and sense, and life, than ours.
 One moment's cold, like theirs, would pierce the bone,
 Freeze the heart-blood, and turn us all to stone.

Strange and amazing must the difference be
 'Twixt this dull planet and bright Mercury:
 Yet reason says, nor can we doubt at all,
 Millions of beings dwell on either ball,
 With constitutions fitted for that spot,
 Where Providence, all-wise, has fix'd their lot.

Wondrous art thou, O God, in all thy ways!
 Their eyes to thee let all thy creatures raise;
 Adore thy grandeur, and thy goodness praise.

Ye sons of men! with satisfaction know,
 God's own right hand dispenses all below:
 Nor good nor evil does by chance befall;
 He reigns supreme, and he directs it all.

At his command, affrighting human-kind,
 Comets drag on their blazing lengths behind:
 Nor, as we think, do they at random rove,
 But, in determin'd times, through long eclipses move.
 And tho' sometimes they near approach the sun,
 Sometimes beyond our system's orbit run;
 Throughout their race they act their Maker's will,
 His pow'r declare, his purposes fulfil.

III. Of those preceptive poems that treat of the business and pleasures of mankind, Virgil's *Georgics* claim our first and principal attention. In these he has laid down the rules of husbandry in all its branches with the utmost exactness and perspicuity, and at the same time embellished them with all the beauties and graces of poetry. Though his subject was husbandry, he has delivered his precepts, as Mr Addison observes, not with the simplicity of a ploughman, but with the address of a poet: the meanest of his rules are laid down with a kind of grandeur; *and he breaks the clods, and tosses about the dung, with an air of gracefulness*. Of the different ways of conveying the same truth to the mind, he takes that which is pleasantest; and this chiefly distinguishes poetry from prose, and renders Virgil's rules of husbandry more delightful and valuable than any other.

These poems, which are esteemed the most perfect of the author's works, are, perhaps, the best that can be proposed for the young student's imitation in this manner of writing; for the whole of his *Georgics* is wrought up with wonderful art, and decorated with all the flowers of poetry.

IV. Of those poems which give precepts for the recreations and pleasures of a country life, we have several in our own language that are justly admired. As the most considerable of those diversions, however, are
 Vol. XV. Part I.

finely treated by Mr Gay in his *Rural Sports*, we particularly refer to that poem.

We should here treat of those preceptive poems that teach the art of poetry itself, of which there are many that deserve particular attention; but we have anticipated our design, and rendered any farther notice of them in a manner useless, by the observations we have made in the course of this treatise. We ought however to remark, that Horace was the only poet among the ancients who wrote precepts for poetry in verse; at least his epistle to the Pisos is the only piece of the kind that has been handed down to us; and that is so perfect, it seems almost to have precluded the necessity of any other. Among the moderns we have several that are justly admired; as Boileau, Pope, &c.

Poets who write in the preceptive manner should take care to choose such subjects as are worthy of their muse, and of consequence to all mankind; for to bestow both parts and pains to teach people trifles that are unworthy of their attention, is to the last degree ridiculous.

Among poems of the useful and interesting kind, Dr Armstrong's *Art of Preserving Health* deserves particular recommendation, as well in consideration of the subject, as of the elegant and masterly manner in which he has treated it; for he has made those things, which are in their own nature dry and unentertaining, perfectly agreeable and pleasing, by adhering to the rules observed by Virgil and others, in the conduct of these poems.

With regard to the style or dress of these poems, it should be so rich as to hide the nakedness of the style. subject, and the barrenness of the precepts should be lost in the lustre of the language. "It ought to abound in the most bold and forcible metaphors, the most glowing and picturesque epithets; it ought to be elevated and enlivened by pomp of numbers and majesty of words, and by every figure that can lift a language above the vulgar and current expressions." One may add, that in no kind of poetry (not even in the sublime ode) is beauty of expression so much to be regarded as in this. For the epic writer should be very cautious of indulging himself in too florid a manner of expression, especially in the dramatic parts of his tale, where he introduces dialogue: and the writer of tragedy cannot fall into so nauseous and unnatural an affectation, as to put laboured descriptions, pompous epithets, studied phrases, and high-flown metaphors, into the mouths of his characters. But as the didactic poet speaks in his own person, it is necessary and proper for him to use a brighter colouring of style, and to be more studious of ornament. And this is agreeable to an admirable precept of Aristotle, which no writer should ever forget,—"That diction ought most to be laboured in the unactive, that is, the descriptive, parts of a poem, in which the opinions, manners, and passions of men are not represented; for too glaring an expression obscures the manners and the sentiments."

We have already observed that any thing in nature may be the subject of this poem. Some things however will appear to more advantage than others, as they give a greater latitude to genius, and admit of more poetical ornaments. Natural history and philosophy are copious subjects. Precepts in these might

Epistle.

be decorated with all the flowers in poetry; and, as Dr Trapp observes, how can poetry be better employed, or more agreeably to its nature and dignity, than in celebrating the works of the great Creator, and describing the nature and generation of animals, vegetables, and minerals; the revolutions of the heavenly bodies; the motions of the earth; the flux and reflux of the sea; the cause of thunder, lightning, and other meteors; the attraction of the magnet; the gravitation, cohesion, and repulsion of matter; the impulsive motion of light; the slow progression of founts; and other amazing phenomena of nature? Most of the arts and sciences are also proper subjects for this poem; and none are more so than its two sister arts, painting and music. In the former, particularly, there is room for the most entertaining precepts concerning the disposal of colours; the arrangement of lights and shades; the secret attractives of beauty; the various ideas which make up the one; the distinguishing between the attitudes proper to either sex, and every passion; the representing prospects of buildings, battles, or the country; and lastly, concerning the nature of imitation, and the power of painting. What a boundless field of invention is here? What room for description, comparison, and poetical fable? How easy the transition, at any time, from the draught to the original, from the shadow to the substance? and from hence, what noble excursions may be made into history, into panegyric upon the greatest beauties or heroes of the past or present age?

SECT. VI. *Of the Epistle.*

150
The character of the epistle.

THIS species of writing, if we are permitted to lay down rules from the examples of our best poets, admits of great latitude, and solicits ornament and decoration: yet the poet is still to consider, that the true character of the epistle is ease and elegance; nothing therefore may be forced or unnatural, laboured, or affected, but every part of the composition should breathe an easy, polite, and unconstrained freedom.

It is suitable to every subject; for as the epistle takes place of discourse, and is intended as a sort of distant conversation, all the affairs of life and researches into nature may be introduced. Those, however, which are fraught with compliment or condolence, that contain a description of places, or are full of pertinent remarks, and in a familiar and humorous way describe the manners, vices, and follies of mankind, are the best; because they are most suitable to the true character of epistolary writing, and (business set apart) are the usual subjects upon which our letters are employed.

All farther rules and directions are unnecessary; for this kind of writing is better learned by example and practice than by precept. We shall therefore, in conformity to our plan, select a few epistles for the reader's imitation; which, as this method of writing has of late much prevailed, may be best taken, perhaps, from our modern poets.

The following letter from Mr Addison to Lord Halifax, contains an elegant description of the curiosities and places about Rome, together with such reflections on the inestimable blessings of liberty as must give pleasure to every Briton, especially when he sees them thus

placed in direct opposition to the baneful influence of slavery and oppression, which are ever to be seen among the miserable inhabitants of those countries.

While you, my lord, the rural shades admire,
And from Britannia's public posts retire,
Nor longer, her ungrateful sons to please,
For their advantage sacrifice your ease;
Me into foreign realms my fate conveys,
Through nations fruitful of immortal lays,
Where the soft season and inviting clime
Conspire to trouble your repose with rhyme.

For wheresoe'er I turn my ravisht eyes,
Gay gilded scenes and shining prospects rise,
Poetic fields encompass me around,
And still I seem to tread on classic ground;
For here the muse so oft her harp has strung,
That not a mountain rears its head unsung,
Renown'd in verse each shady thicket grows,
And ev'ry stream in heav'nly numbers flows.

How am I pleas'd to search the hills and woods
For rising springs and celebrated floods;
To view the Nar, tumultuous in his course,
And trace the smooth Clitumnus to his source;
To see the Mincia draw its wat'ry store
Through the long windings of a fruitful shore,
And hoary Albula's infected tide
O'er the warm bed of smoking sulphur glide!

Fir'd with a thousand raptures, I survey
Eridanus thro' flow'ry meadows stray,
The king of floods! that, rolling o'er the plains,
The tow'ring Alps of half their moisture drains,
And, proudly swoln with a whole winter's snows,
Distributes wealth and plenty where he flows.

Sometimes, misguided by the tuneful throng,
I look for streams immortaliz'd in song,
That lost in silence and oblivion lie,
(Dumb are their fountains and their channels dry)
Yet run for ever by the muse's skill,
And in the smooth description murmur still.

Sometimes to gentle Tiber I retire,
And the fam'd river's empty shores admire,
That, destitute of strength, derives its course
From thirsty urns, and an unfruitful source;
Yet sung so often in poetic lays,
With scorn the Danube and the Nile surveys;
So high the deathless muse exalts her theme!
Such was the Boyn, a poor inglorious stream,
That in Hibernian vales obscurely stray'd,
And unobserv'd in wild meanders play'd;
Till, by your lines, and Nassau's sword renown'd,
Its rising billows through the world resound,
Where'er the hero's godlike acts can pierce,
Or where the fame of an immortal verse.

Oh cou'd the muse my ravisht breast inspire
With warmth like yours, and raise an equal fire,
Unnumber'd beauties in my verse should shine,
And Virgil's Italy should yield to mine!

See how the golden groves around me smile,
That shun the coasts of Britain's stormy isle,
Or when transplanted and preserv'd with care,
Curse the cold clime, and starve in northern air.
Here kindly warmth their mounting juice ferments:
To nobler tastes, and more exalted scents:
Ev'n the rough rocks with tender myrtles bloom,
And trodden weeds send out a rich perfume.

Epistle.

151
Examples
in episto-
lary poetry
from Addi-
son,

Epistle.

Bear me, some god, to Baia's gentle seats,
Or cover me in Umbria's green retreats;
Where western gales eternally reside,
And all the seasons lavish all their pride:
Blossoms, and fruits, and flow'rs together rise,
And the whole year in gay confusion lies.

Immortal glories in my mind revive,
And in my soul a thousand passions strive,
When Rome's exalted beauties I defery
Magnificent in piles of ruin lie.
An amphitheatre's amazing height
Here fills my eye with terror and delight,
That on its public shows unpeopled Rome,
And held uncrowded nations in its womb:
Here pillars rough with sculpture pierce the skies;
And here the proud triumphal arches rise,
Where the old Romans deathless acts display'd,
Their base degenerate progeny upbraid:
Whole rivers here forsake the fields below,
And wond'ring at their height thro' airy channels flow.

Still to new scenes my wand'ring muse retires;
And the dumb show of breathing rocks admires;
Where the smooth chissel all its force has shown,
And soften'd into flesh the rugged stone.
In solemn silence, a majestic band,
Heroes, and gods, and Roman consuls stand,
Stern tyrants, whom their cruelties renown,
And emperors in Parian marble frown;
While the bright dames, to whom they humbly su'd,
Still show the charms that their proud hearts subdu'd.

Fain would I Raphael's godlike art rehearse,
And show th' immortal labours in my verse,
Where from the mingled strength of shade and light
A new creation rises to my sight,
Such heav'nly figures from his pencil flow,
So warm with life his blended colours glow.
From theme to theme with secret pleasure tost,
Amidst the soft variety I'm lost.
Here pleasing airs my ravish'd soul confound
With circling notes and labyrinths of sound;
Here domes and temples rise in distant views,
And opening palaces invite my muse.

How has kind heav'n adorn'd the happy land,
And scatter'd blessings with a wasteful hand!
But what avail her unexhausted stores,
Her blooming mountains, and her sunny shores,
With all the gifts that heav'n and earth impart,
The smiles of nature, and the charms of art,
While proud oppression in her valleys reigns,
And tyranny usurps her happy plains?
The poor inhabitant beholds in vain
The red'ning orange and the swelling grain:
Joyless he sees the growing oils and wines,
And in the myrtle's fragrant shade repines:
Starves, in the midst of nature's bounty curst,
And in the loaded vineyard dies for thirst.

O liberty, thou goddess heav'nly bright,
Profuse of bliss, and pregnant with delight!
Eternal pleasures in thy presence reign,
And smiling plenty leads thy wanton train:
Eas'd of her load, subjection grows more light,
And poverty looks cheerful in thy sight;
Thou mak'st the gloomy face of nature gay,
Giv'st beauty to the sun, and pleasure to the day.

Epistle.

Thee, goddess, thee, Britannia's isle adores;
How has she oft exhausted all her stores,
How oft in fields of death thy presence sought,
Nor thinks the mighty prize too dearly bought!
On foreign mountain may the sun refine
The grape's soft juice, and mellow it to wine,
With citron groves adorn a distant soil,
And the fat olive swell with floods of oil:
We envy not the warmer clime, that lies
In ten degrees of more indulgent skies,
Nor at the coarseness of our heav'n repine,
Tho' o'er our heads the frozen Pleiads shine:
'Tis liberty that crowns Britannia's isle, [smile.
And makes her barren rocks and her bleak mountains

Others with tow'ring piles may please the sight,
And in their proud aspiring domes delight;
A nicer touch to the stretch'd canvas give,
Or teach their animated rocks to live:
'Tis Britain's care to watch o'er Europe's fate,
And hold in balance each contending state,
To threaten bold presumptuous kings with war,
And answer her afflicted neighbour's pray'r.
The Dane and Swede, rous'd up by fierce alarms,
Bless the wise conduct of her pious arms:
Soon as her fleets appear, their terrors cease,
And all the northern world lies hush'd in peace.

Th' ambitious Gaul beholds with secret dread
Her thunder aim'd at his aspiring head,
And fain her godlike sons would disunite
By foreign gold, or by domestic spite;
But strives in vain to conquer or divide,
Whom Nassau's arms defend and counsels guide.

Fir'd with the name, which I so oft have found
The distant climes and diff'rent tongues resound,
I bridle in my struggling muse with pain,
That longs to launch into a bolder strain.
But I've already troubled you too long,
Nor dare attempt a more advent'rous song:
My humble verse demands a softer theme,
A painted meadow, or a purling stream;
Unfit for heroes; whom immortal lays,
And lines like Virgil's, or like yours, should praise.

There is a fine spirit of freedom, and love of liberty,
displayed in the following letter from Lord Lyttleton
to Mr Pope; and the message from the shade of Virgil,
which is truly poetical, and justly preceptive, may prove
an useful lesson to future bards.

From Rome, 1730.

152

Lyttleton,

IMMORTAL bard! for whom each muse has wove
The fairest garlands of the Aonian grove;
Preserv'd, our drooping genius to restore,
When Addison and Congreve are no more;
After so many stars extinct in night,
The darken'd age's last remaining light!
To thee from Latian realms this verse is writ,
Inspir'd by memory of ancient wit:
For now no more these climes their influence boast,
Fall'n is their glory, and their virtue lost;
From tyrants, and from priests, the muses fly,
Daughters of reason and of liberty.

Nor Baia now nor Umbria's plain they love,
Nor on the banks of Nar or Mincia rove;
To Thames's flow'ry borders they retire,
And kindle in thy breast the Roman fire.

H h 2

S2

Epistle.

So in the shades, where cheer'd with summer rays
Melodious linnets warbled brightly lays,
Soon as the faded, falling leaves complain
Of gloomy winter's inauspicious reign,
No tuneful voice is heard of joy or love,
But mournful silence saddens all the grove.

Unhappy Italy! whose alter'd state
Has felt the worst severity of fate:
Not that barbarian hands her fasces broke,
And bow'd her haughty neck beneath their yoke;
Nor that her palaces to earth are thrown,
Her cities desert, and her fields unsown;
But that her ancient spirit is decay'd,
That sacred wisdom from her bounds is fled,
That there the source of science flows no more,
Whence its rich streams supply'd the world before.

Illustrious names! that once in Latium shin'd,
Born to instruct and to command mankind;
Chiefs, by whose virtue mighty Rome was rais'd,
And poets, who those chiefs sublimely prais'd!
Oft I the traces you have left explore,
Your ashes visit, and your urns adore;
Oft kiss, with lips devout, some mould'ring stone,
With ivy's venerable shade o'ergrown;
'Those hallow'd ruins better pleas'd to see,
Than all the pomp of modern luxury.

As late on Virgil's tomb fresh flow'rs I strow'd,
While with th' inspiring muse my bosom glow'd,
Crown'd with eternal bays, my ravish'd eyes
Beheld the poet's awful form arise:
Stranger, he said, whose pious hand has paid
These grateful rites to my attentive shade,
When thou shalt breathe thy happy native air,
To Pope this message from his master bear.

Great bard, whose numbers I myself inspire,
To whom I gave my own harmonious lyre,
If high exalted on the throne of wit,
Near me and Homer thou aspire to sit,
No more let meaner satire dim the rays
That flow majestic from thy noble bays.
In all the flow'ry paths of Pindus stray:
But shun that thorny, that unpleasing way;
Nor, when each soft engaging muse is thine,
Address the least attractive of the nine.

Of thee more worthy were the task to raise
A lasting column to thy country's praise,
To sing the land, which yet alone can boast
That liberty corrupted Rome has lost;
Where science in the arms of peace is laid,
And plants her palm beneath the olive's shade.
Such was the theme for which my lyre I strung,
Such was the people whose exploits I sung;
Brave, yet refin'd, for arms and arts renown'd,
With diff'rent bays by Mars and Phœbus crown'd,
Dauntless opposers of tyrannic sway,
But pleas'd a mild AUGUSTUS to obey.

If these commands submissive thou receive,
Immortal and unblam'd thy name shall live;
Envy to black Cocytus shall retire,
And howl with furies in tormenting fire;
Approving time shall consecrate thy lays,
And join the patriot's to the poet's praise.

The following letter from Mr Philips to the earl of Dorset is entirely descriptive; but is one of those descriptions which will be ever read with delight.

Copenhagen, March 9. 1709.

Epistle.

153
Philips,
and

FROM frozen climes, and endless tracts of snow,
From streams which northern winds forbid to flow,
What present shall the muse to Dorset bring,
Or how, so near the pole, attempt to sing?
The hoary winter here conceals from sight
All pleasing objects which to verse invite.
The hills and dales, and the delightful woods,
The flow'ry plains, and silver-streaming floods,
By snow disguis'd, in bright confusion lie,
And with one dazzling waste fatigue the eye.

No gentle breathing breeze prepares the spring,
No birds within the desert region sing:
The ships, unmov'd, the boist'rous winds defy,
While rattling chariots o'er the ocean fly.
The vast Leviathan wants room to play,
And spout his waters in the face of day:
The starving wolves along the main sea spawl,
And to the moon in icy valleys howl.
O'er many a shining league the level main
Here spreads itself into a glassy plain:
There solid billows of enormous size,
Alps of green ice, in wild disorder rise.
And yet but lately have I seen, ev'n here,
The winter in a lovely dress appear.
Ere yet the clouds let fall the treasur'd snow,
Or winds began through hazy skies to blow,
At evening a keen eastern breeze arose,
And the descending rain unfully'd froze;
Soon as the silent shades of night withdrew,
The ruddy morn disclos'd at once to view
The face of nature in a rich disguise,
And brighten'd ev'ry object to my eyes:
For ev'ry shrub, and ev'ry blade of grass,
And ev'ry pointed thorn, seem'd wrought in glass;
In pearls and rubies rich the hawthorns show,
While through the ice the crimson berries glow.
The thick sprung reeds, which watery marshes yield,
Seem'd polish'd lances in a hostile field.
The stag in limpid currents with surprise,
Sees crystal branches on his forehead rise:
The spreading oak, the beech, and tow'ring pine,
Glaz'd over, in the freezing æther shine.
The frighted birds the rattling branches shun,
Which wave and glitter in the distant sun.

When if a sudden gust of wind arise,
The brittle forest into atoms flies,
The crackling woods beneath the tempest bends,
And in a spangled shower the prospect ends:
Or, if a southern gale the region warm,
And by degrees unbend the wint'ry charm,
The traveller a miry country sees,
And journey sad beneath the dropping trees:
Like some deluded peasant Merlin leads
Thro' fragrant bow'rs and thro' delicious meads,
While here enchanted gardens to him rise,
And airy fabrics there attract his eyes,
His wandering feet the magic paths pursue,
And while he thinks the fair illusion true,
The trackless scenes disperse in fluid air,
And woods, and wilds, and thorny ways appear;
A tedious road the weary wretch returns,
And, as he goes, the transient vision mourns.

The great use of medals is properly described in the ensuing elegant epistle from Mr Pope to Mr Addison;
and

Epistle.

Epistle.

174
Pope.

and the extravagant passion which some people entertain only for the colour of them, is very agreeably and very justly ridiculed.

SEE the wild waste of all devouring years !
How Rome her own sad sepulchre appears !
With nodding arches, broken temples spread !
The very tombs now vanish like their dead !
Imperial wonders rais'd on nations spoil'd,
Where mix'd with slaves the groaning martyr toil'd !
Huge theatres, that now unpeopled woods,
Now drain'd a distant country of her floods !
Fanes, which admiring gods with pride survey,
Statues of men, scarce less alive than they !
Some felt the silent stroke of mould'ring age,
Some hostile fury, some religious rage ;
Barbarian blindness, Christian zeal conspire,
And papal piety, and Gothic fire.
Perhaps, by its own ruin sav'd from flame,
Some bury'd marble half preserves a name :
That name the learn'd with fierce disputes pursue,
And give to Titus old Vespasian's due.

Ambition sigh'd : She found it vain to trust
The faithless column and the crumbling bust ;
Huge moles, whose shadow stretch'd from shore to shore,
Their ruins perish'd, and their place no more !
Convinc'd, she now contracts her vast design,
And all her triumphs shrink into a coin.
A narrow orb each crowded conquest keeps,
Beneath her palm here sad Judæa weeps ;
Now scantier limits the proud arch confine,
And scarce are seen the prostrate Nile or Rhine ;
A small Euphrates through the piece is roll'd,
And little eagles wave their wings in gold.

The medal, faithful to its charge of fame,
Through climes and ages bears each form and name :
In one short view subjected to our eye,
Gods, emperors, heroes, sages, beauties, lie,
With sharpen'd sight pale antiquaries pore,
Th' inscription value, but the rust adore.
This the blue varnish, that the green endears,
The sacred rust of twice ten hundred years !
To gain Precennius one employs his schemes,
One grasps a Cecrops in ecstatic dreams.
Poor Vadius, long with learned spleen devour'd,
Can taste no pleasure since his shield was scour'd :
And Curio, restless by the fair one's side,
Sighs for an Otho, and neglects his bride.

Their's is the vanity, the learning thine :
Touch'd by thy hand, again Rome's glories shine ;
Her gods and god-like heroes rise to view,
And all her faded garlands bloom anew.
Nor blush these studies thy regard engage ;
These pleas'd the fathers of poetic rage ;
The verse and sculpture bore an equal part,
And art reflected images to art.

Oh when shall Britain, conscious of her claim,
Stand emulous of Greek and Roman fame ?
In living medals see her wars enroll'd,
And vanquish'd realms supply recording gold ?
Here, rising bold, the patriot's honest face ;
There, warriors frowning in historic bras ?
Then future ages with delight shall see
How Plato's, Bacon's, Newton's, looks agree ;
Or in fair series laurel'd bards be shown,
A Virgil there, and here an Addison.

Then shall thy CRAGGS (and let me call him mine)
On the cast ore, another Pollio shine ;
With aspect open shall erect his head,
And round the orb in lasting notes be read,
" Statesman, yet friend to truth ! of soul sincere,
" In action faithful, and in honour clear ;
" Who broke no promise, serv'd no private end,
" Who gain'd no title, and who lost no friend ;
" Ennobled by himself, by all approv'd,
" Prais'd, wept, and honour'd, by the muse he lov'd."

We have already observed, that the essential, and indeed the true characteristic of epistolary writing, is ease ; and on this account, as well as others, the following letter from Mr Pope to Miss Blount is to be admired.

To Miss BLOUNT, on her leaving the Town after the Coronation.

As some fond virgin, whom her mother's care
Drags from the town to wholesome country air ;
Just when she learns to roll a melting eye,
And hear a spark, yet think no danger nigh ;
From the dear man unwilling she must sever,
Yet takes one kiss before she parts for ever :
Thus from the world fair Zephalinda flew,
Saw others happy, and with sighs withdrew :
Not that their pleasures caus'd her discontent ;
She sigh'd, not that they stay'd, but that she went.

She went, to plain-work, and to pulling brooks,
Old-fashion'd halls, dull aunts, and croaking rooks :
She went from op'ra, park, assembly, play,
To morning-walks, and pray'rs three hours a-day ;
To part her time 'twixt reading and bohea,
To muse, and spill her solitary tea,
Or o'er cold coffee trifle with the spoon,
Count the slow clock, and dine exact at noon ;
Divert her eyes with pictures in the fire,
Hum half a tune, tell stories to the 'squire ;
Up to her godly garret after seven,

There starve and pray, for that's the way to heav'n.
Some 'squire, perhaps, you take delight to rack ;
Whose game is whiff, whose treat's a toast in sack ;
Who visits with a gun, presents you birds,
Then gives a smacking buff, and cries,—no words !
Or with his hound comes hollowing from the stable,
Makes love with nods, and knees beneath a table ;
Whose laughs are hearty, tho' his jests are coarse,
And loves you best of all things—but his horse.

In some fair ev'ning, on your elbow laid,
You dream of triumphs in the rural shade ;
In pensive thought recal the fancy'd scene,
See coronations rise on every green ;
Before you pass th' imaginary fights
Of lords, and earls, and dukes, and garter'd knights,
While the spread fan o'er shades your closing eyes :
Then give one flirt, and all the vision flies.
Thus vanish sceptres, coronets, and balls,
And leave you in lone woods, or empty walls !

So when your slave, at some dear idle time,
(Not plagu'd with head-achs, or the want of rhyme)
Stands in the streets, abstracted from the crew,
And while he seems to study, thinks of you ;
Just when his fancy points your sprightly eyes,
Or sees the blush of lost Parthenia rise,

Gay

Descriptive. Gay pats my shoulder, and you vanish quite,
Streets, chairs, and cockcombs, rush upon my sight;
Vex'd to be still in town, I knit my brow,
Look four, and hum a tune, as you may now.

SECT. VII. *Of Descriptive Poetry.*

155
*Descriptive
poetry.*

DESCRIPTIVE poetry is of universal use, since there is nothing in nature but what may be described. As poems of this kind, however, are intended more to delight than to instruct, great care should be taken to make them agreeable. Descriptive poems are made beautiful by similes properly introduced, images of feigned persons, and allusions to ancient fables or historical facts; as will appear by a perusal of the best of these poems, especially Milton's *L'Allegro* and *Il Penseroso*, Denham's *Cooper Hill*, and Pope's *Windsor Forest*. Every body being in possession of Milton's works, we forbear inserting the two former; and the others are too long for our purpose. That inimitable poem, *The Seasons*, by Mr Thomson, notwithstanding some parts of it are didactic, may be also with propriety referred to this head.

SECT. VIII. *Of Allegorical Poetry.*

156
*Origin of
allegorical
poetry.*

COULD truth engage the affections of mankind in her native and simple dress, she would require no ornament or aid from the imagination; but her delicate light, though lovely in itself, and dear to the most discerning, does not strike the senses of the multitude so as to secure their esteem and attention: the poets therefore dressed her up in the manner in which they thought she would appear the most amiable, and called in allegories and airy disguises as her auxiliaries in the cause of virtue.

157
*Its charac-
ter.*

An allegory is a fable or story, in which, under the disguise of imaginary persons or things, some real action or instructive moral is conveyed to the mind. Every allegory therefore has two senses, the one literal and the other mystical; the first has been aptly enough compared to a dream or vision, of which the last is the true meaning or interpretation.

From this definition of allegorical poetry the reader will perceive that it gives great latitude to genius, and affords such a boundless scope for invention, that the poet is allowed to soar beyond all creation; to give life and action to virtues, vices, passions, diseases, and natural and moral qualities; to raise floating islands, enchanted palaces, castles, &c. and to people them with the creatures of his own imagination.

The poet's eye, in a fine frenzy rolling,
Doth glance from heav'n to earth, from earth to heav'n;
And, as imagination bodies forth
The forms of things unknown, the poet's pen
Turns them to shape, and gives to airy nothing
A local habitation and a name.

SHAKESPEARE.

But whatever is thus raised by the magic of his mind must be visionary and typical, and the mystical sense must appear obvious to the reader, and inculcate some moral or useful lesson in life; otherwise the whole will be deemed rather the effects of a disordered brain, than the productions of real wit and genius. The poet, like Jason, may sail to parts unexplored, but will meet with

no applause if he returns without a golden fleece; for these romantic reveries would be unpardonable but for the mystical meaning and moral that is thus artfully and agreeably conveyed with them, and on which account only the allegory is indulged with a greater liberty than any other sort of writing.

The ancients justly considered this sort of allegory as the most essential part of poetry; for the power of raising images of things not in being, giving them a sort of life and action, and presenting them as it were before the eyes, was thought to have something in it like creation: but then, in such compositions, they always expected to find a meaning couched under them of consequence; and we may reasonably conclude, that the allegories of their poets would never have been handed down to us, had they been deficient in this respect.

As the *fable* is the part immediately offered to the reader's consideration, and intended as an agreeable vehicle to convey the moral, it ought to be bold, lively, and surprising, that it may excite curiosity and support attention; for if the fable be spiritless and barren of invention, the attention will be disengaged, and the moral, however useful and important in itself, will be little regarded.

There must likewise be a justness and propriety in the fable, that is, it must be closely connected with the subject on which it is employed; for notwithstanding the boundless compass allowed the imagination in these writings, nothing absurd or useless is to be introduced. In epic poetry some things may perhaps be admitted for no other reason but to surprise, and to raise what is called the *wonderful*, which is as necessary to the epic as the *probable*; but in allegories, however wild and extravagant the fable and the persons introduced, each must correspond with the subject they are applied to, and, like the members of a well-written simile, bear a due proportion and relation to each other: for we are to consider, that the allegory is a sort of extended or rather multiplied simile, and therefore, like that, should never lose the subject it is intended to illustrate. Whence it will appear, that genius and fancy are here insufficient without the aid of taste and judgment: these first, indeed, may produce a multitude of ornaments, a wilderness of sweets; but the last must be employed to accommodate them to reason, and to arrange them so as to produce pleasure and profit.

But it is not sufficient that the fable be correspondent with the subject, and have the properties above described; for it must also be consistent with itself. The poet may invent what story he pleases, and form any imaginary beings that his fancy shall suggest; but here, as in dramatic writings, when persons are once introduced, they must be supported to the end, and all speak and act in character: for notwithstanding the general licence here allowed, some order must be observed; and however wild and extravagant the characters, they should not be absurd. To this let me add, that the whole must be clear and intelligible; for the "fable (as Mr Hughes observes) being designed only to clothe and adorn the moral, but not to hide it, should resemble the draperies we admire in some of the ancient statues, in which the folds are not too many nor too thick, but so judiciously ordered, that the shape and beauty of the limbs may be seen through them."—But this will more obviously appear from a perusal of the

Allegorical.

158
*Essentials
of a just
fable.*

egorical: the best compositions of this class; such as Spenser's Fairy Queen, Thomson's Castle of Indolence, Addison and Johnson's beautiful allegories in the Spectator and Rambler, &c. &c.

The word *allegory* has been used in a more extensive sense than that in which we have here applied it: for all writings, where the moral is conveyed under the cover of borrowed characters and actions, by which other characters and actions (that are real) are represented, have obtained the name of *allegories*; though the fable or story contains nothing that is visionary or romantic, but is made up of real or historical persons, and of actions either probable or possible. But these writings should undoubtedly be distinguished by some other name, because the literal sense is consistent with right reason, and may convey an useful moral, and satisfy the reader, without putting him under the necessity of seeking for another.

Some of the ancient critics, as Mr Addison observes, were fond of giving the works of their poets this second or concealed meaning, though there was no apparent necessity for the attempt, and often but little show of reason in the application. Thus the *Iliad* and *Odyssey* of Homer are said to be fables of this kind, and that the gods and heroes introduced are only the affections of the mind represented in a visible shape and character. They tell us, says he, that Achilles in the first *Iliad* represents anger, or the irascible part of human nature: that upon drawing his sword against his superior, in a full assembly, Pallas (which, say they, is another name for reason) checks and advises him on the occasion, and at her first appearance touches him upon the head; that part of the man being looked upon as the seat of reason. In this sense, as Mr Hughes has well observed, the whole *Æneid* of Virgil may be said to be an allegory, if you suppose *Æneas* to represent Augustus Cæsar, and that his conducting the remains of his countrymen from the ruins of Troy, to a new settlement in Italy, is an emblem of Augustus's forming a new government out of the ruins of the aristocracy, and establishing the Romans, after the confusion of the civil war, in a peaceable and flourishing condition. However ingenious this coincidence may appear, and whatever design Virgil had in view, he has avoided a particular and direct application, and so conducted his poem, that it is perfect without any allegorical interpretation; for whether we consider *Æneas* or Augustus as the hero, the morals contained are equally instructive. And indeed it seems absurd to suppose, that because the epic poets have introduced some allegories into their works, every thing is to be understood in a mystical manner, where the sense is plain and evident without any such application. Nor is the attempt that Tasso made to turn his Jerusalem into a mystery, any particular recommendation of the work: for notwithstanding he tells us, in what is called the *allegory*, printed with it, that the Christian army represents man, the city of Jerusalem civil happiness, Godfrey the understanding, Rinaldo and Tancred the other powers of the soul, and that the body is typified by the common soldiers and the like; yet the reader will find himself as little delighted as edified by the explication: for the mind has little pleasure in an allegory that cannot be opened without a key made by the hand of the same artist; and indeed every allegory that is so dark, and, as it were, inexplicable, loses its

very essence, and becomes an enigma or riddle, that is ^{Allegorical.} left to be interpreted by every crude imagination.

This last species of writing, whether called an *allegory*, or by any other name, is not less eminent and useful; for the introducing of real or historical persons may not abridge or lessen either our entertainment or instruction. In these compositions we often meet with an uncommon moral conveyed by the fable in a new and entertaining manner; or with a known truth so artfully decorated, and placed in such a new and beautiful light, that we are amazed how any thing so charming and useful should so long have escaped our observation. Such, for example, are many of Johnson's pieces published in the Rambler under the title of *Eastern Stories*, and by Hawkesworth in the Adventurer.

The ancient parables are of this species of writing: and it is to be observed, that those in the New Testament have a most remarkable elegance and propriety; and are the most striking, and the most instructive, for being drawn from objects that are familiar.—The more striking, because, as the things are seen, the moral conveyed becomes the object of our senses, and requires little or no reflection:—the more instructive, because every time they are seen, the memory is awakened, and the same moral is again exhibited with pleasure to the mind, and accustoms it to reason and dwell on the subject. So that this method of instruction improves nature, as it were, into a book of life; since every thing before us may be so managed, as to give lessons for our advantage. Our Saviour's parables of the sower and the seed, of the tares, of the mustard-seed, and of the leaven (Matthew xiii.), are all of this kind, and were obviously taken from the harvest just ripening before him; for *his disciples plucked the ears of corn and did eat, rubbing them in their hands*. See the articles ALLEGORY, and METAPHOR and Allegory, in the general alphabet.

SECT. IX. Of Fables.

No method of instruction has been more ancient, ¹⁶⁰ more universal, and probably none more effectual, than ^{The apo-} that by ^{logue or} apologue or fable. In the first ages, amongst ^{fable.} a rude and fierce people, this perhaps was the only method that would have been borne; and even since the progress of learning has furnished other helps, the fable, which at first was used through necessity, is retained from choice, on account of the elegant happiness of its manner, and the refined address with which, when well conducted, it insinuates its moral.

As to the actors in this little drama, the fabulist has authority to press into his service every kind of existence under heaven; not only beasts, birds, insects, and all the animal creation; but flowers, shrubs, trees, and all the tribe of vegetables. Even mountains, fossils, minerals, and the inanimate works of nature, discourse articulately at his command, and act the part which he assigns them. The virtues, vices, and every property of beings, receive from him a local habitation and a name. In short, he may personify, bestow life, speech, and action, on whatever he thinks proper.

It is easy to imagine what a source of novelty and variety this must open to a genius capable of conceiving and of employing these ideal persons in a proper manner; what an opportunity it affords him to diver-

Of Fables, fify his images, and to treat the fancy with changes of objects, while he strengthens the understanding, or regulates the passions, by a succession of truths. To raise beings like these into a state of action and intelligence, gives the fabulist an undoubted claim to that first character of the poet, a *creator*.

167
Rules for
is con-
struction.

When these persons are once raised, we must carefully enjoin them proper tasks, and assign them sentiments and language suitable to their several natures and respective properties. A raven should not be extolled for her voice, nor a bear be represented with an elegant shape. It were a very obvious instance of absurdity, to paint a hare cruel, or a wolf compassionate. An ass were but ill qualified to be general of an army, though he may well enough serve, perhaps, for one of the trumpeters. But so long as popular opinion allows to the lion magnanimity, rage to the tiger, strength to the mule, cunning to the fox, and buffoonery to the monkey; why may not they support the characters of an Agamemnon, Achilles, Ajax, Ulysses, and Thersites? The truth is, when moral actions are with judgment attributed to the brute creation, we scarce perceive that nature is at all violated by the fabulist. He appears at most to have only translated their language. His lions, wolves, and foxes, behave and argue as those creatures would, had they originally been endowed with the human faculties of speech and reason.

But greater art is yet required whenever we personify inanimate beings. Here the copy so far deviates from the great lines of nature, that, without the nicest care, reason will revolt against the fiction. However, beings of this sort, managed ingeniously and with address, recommend the fabulist's invention by the grace of novelty and of variety. Indeed the analogy between things natural and artificial, animate and inanimate, is often so very striking, that we can, with seeming propriety, give passions and sentiments to every individual part of existence. Appearance favours the deception. The vine may be enamoured of the elm; her embraces testify her passion. The swelling mountain may, naturally enough, be delivered of a mouse. The gourd may reproach the pine, and the sky-rocket insult the stars. The axe may solicit a new handle of the forest; and the moon, in her female character, request a fashionable garment. Here is nothing incongruous; nothing that shocks the reader with impropriety. On the other hand, were the axe to desire a periwig, and the moon petition for a new pair of boots, probability would then be violated, and the absurdity become too glaring.

The most beautiful fables that ever were invented may be disfigured by the language in which they are clothed. Of this poor Æsop, in some of his English dresses, affords a melancholy proof. The ordinary style of fable should be familiar, but also elegant.

The familiar, says Mr La Motte, is the general tone or accent of fable. It was thought sufficient, on its first appearance, to lend the animals our most common language. Nor indeed have they any extraordinary pretensions to the sublime; it being requisite they should speak with the same simplicity that they behave.

The familiar also is more proper for insinuation than

the elevated; this being the language of reflection, as the former is the voice of sentiment. We guard ourselves against the one, but lie open to the other; and instruction will always the most effectually sway us, when it appears least jealous of its rights and privileges.

The familiar style, however, that is here required, notwithstanding that appearance of ease which is its character, is perhaps more difficult to write than the more elevated or sublime. A writer more readily perceives when he has risen above the common language, than he perceives, in speaking this language, whether he has made the choice that is most suitable to the occasion: and it is, nevertheless, upon this happy choice that all the charms of the familiar depend. Moreover, the elevated style deceives and seduces, although it be not the best chosen; whereas the familiar can procure itself no sort of respect, if it be not easy, natural, just, delicate, and unaffected. A fabulist must therefore bestow great attention upon his style; and even labour it so much the more, that it may appear to have cost him no pains at all.

The authority of Fontaine justifies these opinions in regard to style. His fables are perhaps the best examples of the genteel familiar, as Sir Roger L'Estrange affords the grossest of the indelicate and low. When we read, that "while the frog and the mouse were disputing it at sword's-point, down comes a kite powdering upon them in the interim, and gobbets up both together to part the fray;" and "where the fox reproaches a bevy of jolly gossiping wenches making merry over a dish of pullets, that if he but peeped into a hen-roost, they always made a bawling with their dogs and their bastards; while you yourselves (says he) can lie stuffing your guts with your hens and capons, and not a word of the pudding?" This may be familiar; but it is also coarse and vulgar, and cannot fail to disgust a reader that has the least degree of taste or delicacy.

The style of fable then must be simple and familiar; and it must likewise be correct and elegant. By the former, we mean, that it should not be loaded with figure and metaphor; that the disposition of words be natural, the turn of sentences easy, and their construction unembarrassed. By elegance, we would exclude all coarse and provincial terms; all affected and puerile conceits; all obsolete and pedantic phrases. To this we would adjoin, as the word perhaps implies, a certain finishing polish, which gives a grace and spirit to the whole; and which, though it have always the appearance of nature, is almost ever the effect of art.

But notwithstanding all that has been said, there are some occasions on which it is allowable, and even expedient, to change the style. The language of a fable must rise or fall in conformity to the subject. A lion, when introduced in his regal capacity, must hold discourse in a strain somewhat more elevated than a country-mouse. The lioness then becomes his queen, and the beasts of the forest are called his subjects: a method that offers at once to the imagination both the animal and the person he is designed to represent. Again, the buffoon-monkey should avoid that pomp of phrase, which the owl employs as her best pretence to

162
The pro-
per style
of fable.

Satire.

wisdom. Unless the style be thus judiciously varied, it will be impossible to preserve a just distinction of character.

Descriptions, at once concise and pertinent, add a grace to fable; but are then most happy when included in the action: whereof the fable of Boreas and the Sun affords us an example. An epithet well chosen is often a description in itself; and so much the more agreeable, as it the less retards us in our pursuit of the catastrophe.

Lastly, little strokes of humour when arising naturally from the subject, and incidental reflections when kept in due subordination to the principal, add a value to these compositions. These latter, however, should be employed very sparingly, and with great address; be very few, and very short: it is scarcely enough that they naturally spring out of the subject; they should be such as to appear necessary and essential parts of the fable. And when these embellishments, pleasing in themselves, tend to illustrate the main action, they then afford that nameless grace remarkable in Fontaine and some few others, and which persons of the best discernment will more easily conceive than they can explain.

SECT. X. Of Satire.

163
Origin of
Satire.

THIS kind of poem is of very ancient date, and (if we believe Horace) was introduced, by way of interlude, by the Greek dramatic poets in their tragedies, to relieve the audience, and take off the force of those strokes which they thought too deep and affecting. In those satirical interludes, the scene was laid in the country; and the persons were rural deities, satyrs, country peasants, and other rustics.

The first Tragedians found that serious style
Too grave for their uncultivated age,
And so brought wild and naked Satyrs in
(Whose motion, words, and shape, were all a farce)
As oft as decency would give them leave;
Because the mad, ungovernable rout,
Full of confusion and the fumes of wine,
Lov'd such variety and antic tricks.

ROSCOMMON'S *Horace*.

The satire we now have is generally allowed to be of Roman invention. It was first introduced without the decorations of scenes and action; but written in verses of different measures by Ennius, and afterwards moulded into the form we now have it by Lucilius, whom Horace has imitated, and mentions with esteem. This is the opinion of most of the critics, and particularly of Boileau, who says,

Lucilius led the way, and, bravely bold,
To Roman vices did the mirror hold;
Protected humble goodness from reproach,
Show'd worth on foot, and rascals in a coach.
Horace his pleasing wit to this did add,
That none, uncensur'd, might be fools or mad:
And Juvenal, with rhetorician's rage,
Scourg'd the rank vices of a wicked age;
Tho' horrid truths thro' all his labours shine,
In what he writes there's something of divine.

Our satire, therefore, may be distinguished into two
VOL. XV. Part I.

kinds; the *jocose*, or that which makes sport with vice and folly, and sets them up to ridicule; and the *serious*, or that which deals in asperity, and is severe and acrimonious. Horace is a perfect master of the first, and Juvenal much admired for the last. The one is facetious, and smiles: the other is angry, and storms. The foibles of mankind are the object of one; but crimes of a deeper dye have engaged the other. They both agree, however, in being pungent and biting: and from a due consideration of the writings of these authors, who are our masters in this art, we may define satire to be, A free, (and often *jocose*), witty, and of it. sharp poem, wherein the follies and vices of men are lashed and ridiculed in order to their reformation. Its subject is whatever deserves our contempt or abhorrence, (including every thing that is ridiculous and absurd, or scandalous and repugnant to the golden precepts of religion and virtue.) Its manner is *invective*; and its end, *shame*. So that satire may be looked upon as the physician of a disordered mind, which it endeavours to cure by bitter and unfavoury, or by pleasant and salutary, applications.

A good satirist ought to be a man of wit and address, sagacity and eloquence. He should also have a great deal of good-nature, as all the sentiments which are beautiful in this way of writing must proceed from that quality in the author. It is good-nature produces that disdain of all baseness, vice, and folly, which prompts the poet to express himself with such smartness against the errors of men, but without bitterness to their persons. It is this quality that keeps the mind even, and never lets an offence unseasonably throw the satirist out of his character.

In writing satire, care should be taken that it be true and general; that is, levelled at abuses in which numbers are concerned: for the personal kind of satire, or lampoon, which exposes particular characters, and affects the reputation of those at whom it is pointed, is scarce to be distinguished from scandal and defamation. The poet also, whilst he is endeavouring to correct the guilty, must take care not to use such expressions as may corrupt the innocent: he must therefore avoid all obscene words and images that tend to debase and mislead the mind. Horace and Juvenal, the chief satirists among the Romans, are faulty in this respect, and ought to be read with caution.

The style proper for satire is sometimes grave and animated, inveighing against vice with warmth and earnestness; but that which is pleasant, sportive, and, with becoming raillery, bansters men out of their bad dispositions, has generally the best effect, as it seems only to play with their follies, though it omits no opportunity of making them feel the lash. The verses should be smooth and flowing, and the language manly, just, and decent.

Of well-chosen words some take not care enough,
And think they should be as the subject rough:
But satire must be more exactly made,
And sharpest thoughts in smoothest words convey'd.

Duke of Bucks's *Essays*.

Satires, either of the *jocose* or *serious* kind, may be written in the epistolary manner, or by way of dialogue. Horace, Juvenal, and Persius, have given us examples

Satire.

of both. Nay, some of Horace's satires may, without incongruity, be called *epistles*, and his epistles *satires*. But this is obvious to every reader.

Of the facetious kind, the second satire of the second book of Horace imitated by Mr Pope, and Swift's verses on his own death, may be referred to as examples.

As to those satires of the serious kind, for which Juvenal is so much distinguished, the characteristic properties of which are, morality, dignity, and severity; a better example cannot be mentioned than the poem entitled *London*, written in imitation of the third satire of Juvenal, by Dr Johnson, who has kept up to the spirit and force of the original.

Nor must we omit to mention Dr Young's *Love of Fame the Universal Passion*, in seven satires; which, though characteristical, abound with morality and good sense. The characters are well selected, the ridicule is high, and the satire well pointed and to the purpose.

We have already observed, that personal satire approaches too near defamation, to deserve any countenance or encouragement. Dryden's *Mack Flecknoe* is for this reason exceptionable, but as a composition it is inimitable.

We have dwelt thus long on the present subject, because there is reason to apprehend, that the benefits arising from well-conducted satire have not been sufficiently considered. A satire may often do more service to the cause of religion and virtue than a sermon; since it gives pleasure, at the same time that it creates fear or indignation, and conveys its sentiments in a manner the most likely to captivate the mind.

Of all the ways that wisest men could find
To mend the age and mortify mankind,
Satire well writ has most successful prov'd,
And cures, because the remedy is lov'd.

Duke of Bucks's *Essay*.

But to produce the desired effect, it must be jocose, free, and impartial, though severe. The satirist should always preserve good-humour; and, however keen he cuts, should cut with kindness. When he loses temper, his weapons will be inverted, and the ridicule he threw at others will retort with contempt upon himself: for the reader will perceive that he is angry and hurt, and consider his satire as the effect of malice, not of judgment; and that it is intended rather to wound persons than reform manners.

Rage you must hide, and prejudice lay down:
A satyr's smile is sharper than his frown.

The best, and indeed the only, method to expose vice and folly effectually, is to turn them to ridicule, and hold them up for public contempt; and as it most offends these objects of satire, so it least hurts ourselves. One passion frequently drives out another; and as we cannot look with indifference on the bad actions of men (for they must excite either our wrath or contempt), it is prudent to give way to that which most offends vice and folly, and least affects ourselves; and to sneer and laugh, rather than be angry and scold.

Burlesque poetry, which is chiefly used by way of drollery and ridicule, falls properly to be spoken of under the head of satire. An excellent example of

this kind is a poem in blank verse, intitled *The Splendid Shilling*, written by Mr John Philips, which, in the opinion of one of the best judges of the age, is the finest burlesque in the English language. In this poem the author has handled a low subject in the lofty style and numbers of Milton; in which way of writing Mr Philips has been imitated by several, but none have come up to the humour and happy turn of the original. When we read it, we are betrayed into a pleasure that we could not expect; though, at the same time, the sublimity of the style, and gravity of the phrase, seem to chastise that laughter which they provoke.

There is another sort of verse and style, which is most frequently made use of in treating any subject in a ludicrous manner, viz. that which is generally called *Hudibrastic*, from Butler's admirable poem intitled *Hudibras*. Almost every one knows, that this poem is a satire upon the authors of our civil dissensions in the reign of king Charles I. wherein the poet has, with abundance of wit and humour, exposed and ridiculed the hypocrisy or blind zeal of those unhappy times. In short, it is a kind of burlesque epic poem, which, for the oddity of the rhymes, the quaintness of the similes, the novelty of the thoughts, and that fine raillery which runs through the whole performance, is not to be paralleled.

SECT. XI. Of the Epigram.

THE epigram is a little poem, or composition in verse, treating of one thing only, and whose distinguishing characters are brevity, beauty, and point.

The word *epigram* signifies "inscription;" for epigrams derive their origin from those inscriptions placed by the ancients on their statues, temples, pillars, triumphal arches, and the like; which, at first, were very short, being sometimes no more than a single word; but afterwards, increasing their length, they made them in verse, to be the better retained by the memory. This short way of writing came at last to be used upon any occasion or subject; and hence the name of *epigram* has been given to any little copy of verses, without regard to the original application of such poems.

Its usual limits are from two to 20 verses, though sometimes it extends to 50; but the shorter, the better it is, and the more perfect, as it partakes more of the nature and character of this kind of poem: besides, the epigram, being only a single thought, ought to be expressed in a little compass, or else it loses its force and strength.

The beauty required in an epigram is an harmony and apt agreement of all its parts, a sweet simplicity, and polite language.

The point is a sharp, lively, unexpected turn of wit, with which an epigram ought to be concluded. There are some critics, indeed, who will not admit the point in an epigram; but require that the thought be equally diffused through the whole poem, which is usually the practice of Catullus, as the former is that of Martial. It is allowed there is more delicacy in the manner of Catullus; but the point is more agreeable to the general taste, and seems to be the chief characteristic of the epigram.

This sort of poem admits of all manner of subjects, provided that brevity, beauty, and point, are preferred; admits.

Epigram.

168
Burlesque
poetry.—
Splendid
Shilling.—
Hudibras.167
Benefits of
well-con-
ducted sa-
tire.169
Character
of the epi-
gram.

170

ved; but it is generally employed either in praise or satire.

Though the best epigrams are said to be such as are comprised in two or four verses, we are not to understand it as if none can be perfect which exceed those limits. Neither the ancients nor moderns have been so scrupulous with respect to the length of their epigrams; but, however, brevity in general is always to be studied in these compositions.

171
Examples
of English
epigrams
remarkable
for their
delicacy,
and

For examples of good epigrams in the English language, we shall make choice of several in the different tastes we have mentioned; some remarkable for their delicate turn and simplicity of expression; and others for their salt and sharpness, their equivocating pun, or pleasant allusion. In the first place, take that of Mr Pope, said to be written on a glass with the earl of Chesterfield's diamond-pencil.

Accept a miracle, instead of wit;
See two dull lines by Stanhope's pencil writ.

The beauty of this epigram is more easily seen than described; and it is difficult to determine, whether it does more honour to the poet who wrote it, or to the nobleman for whom the compliment is designed.—The following epigram of Mr Prior is written in the same taste, being a fine encomium on the performance of an excellent painter.

On a Flower, painted by VARELST.

When fam'd Varelst this little wonder drew,
Flora vouchsaf'd the growing work to view:
Finding the painter's science at a stand,
The goddess snatch'd the pencil from his hand,
And, finishing the piece, she smiling said,
Behold one work of mine which ne'er shall fade.

Another compliment of this delicate kind he has made Mr Howard in the following epigram.

VENUS Mislaken.

When Chloe's picture was to Venus shown;
Surpris'd, the goddess took it for her own.
And what, said she, does this bold painter mean?
When was I bathing thus, and naked seen?
Pleas'd Cupid heard, and check'd his mother's pride:
And who's blind now, mamma? the urchin cry'd.
'Tis Chloe's eye, and cheek, and lip, and breast:
Friend Howard's genius fancy'd all the rest.

Most of Mr Prior's epigrams are of this delicate cast, and have the thought, like those of Catullus, diffused through the whole. Of this kind is his address

To CHLOE Weeping.

See, whilst thou weep'st, fair Chloe, see
The world in sympathy with thee.
The cheerful birds no longer sing,
Each drops his head, and hangs his wing.
The clouds have bent their bosom lower,
And shed their sorrow in a shower.
The brooks beyond their limits flow,
And louder murmurs speak their woe:
The nymphs and swains adopt thy cares;
They heave thy sighs, and weep thy tears.
Fantastic nymph! that grief should move
Thy heart obdurate against love.

Strange tears! whose pow'r can soften all
But that dear breast on which they fall.

The epigram written on the leaves of a fan by Dr Atterbury, late bishop of Rochester, contains a pretty thought, expressed with ease and conciseness, and closed in a beautiful manner.

On a FAN.

Flavia the least and slightest toy
Can with resistless art employ.
This fan in meaner hands would prove
An engine of small force in love:
Yet she, with graceful air and mien,
Not to be told or safely seen,
Directs its wanton motion so,
That it wounds more than Cupid's bow,
Gives coolness to the matchless dame,
To ev'ry other breast a flame.

We shall now select some epigrams of the biting and satirical kind, and such as turn upon the *pun* or *equi-point*, as the French call it: in which sort the point is more conspicuous than in those of the former character.

The following distich is an admirable epigram, having all the necessary qualities of one, especially point and brevity.

On a Company of bad DANCERS to good Music.

How ill the motion with the music suits!
So Orpheus fiddled, and so danc'd the brutes.

This brings to mind another epigram upon a bad fiddler, which we shall venture to insert merely for the humour of it, and not for any real excellence it contains.

To a bad FIDDLER.

Old Orpheus play'd so well, he mov'd Old Nick;
But thou mov'st nothing but thy fiddle-stick.

One of Martial's epigrams, wherein he agreeably rallies the foolish vanity of a man who hired people to make verses for him, and published them as his own, has been thus translated into English:

Paul, so fond of the name of a poet is grown,
With gold he buys verses, and calls them his own.
Go on, master Paul; nor mind what the world says,
They are surely his own for which a man pays.

Some bad writer having taken the liberty to censure Mr Prior, the poet very wittily lashed his impertinence in this epigram:

While faster than his costive brain indites,
Philo's quick hand in flowing letters writes,
His case appears to me like honest Teague's,
When he was run away with by his legs.
Phœbus, give Philo o'er himself command;
Quicken his senses, or restrain his hand:
Let him be kept from paper, pen, and ink;
So he may cease to write, and learn to think.

Mr Wesley has given us a pretty epigram, alluding to a well-known text of Scripture, on the setting up a monument in Westminster Abbey, to the memory of the ingenious Mr Butler, author of *Hudibras*.

Epitaph.

While Butler, needy wretch, was yet alive,
No generous patron would a dinner give.
See him when starv'd to death, and turn'd to dust,
Presented with a monumental bust!
The poet's fate is here in emblem shown;
He ask'd for *Bread*, and he receiv'd a *Stone*.

We shall close this section with an epigram written on the well-known story of *Apollo* and *Daphne*, by Mr Smart.

When Phœbus was am'rous and long'd to be rude,
Miss Daphne cry'd Pish! and ran swift to the wood;
And rather than do such a naughty affair,
She became a fine laurel to deck the god's hair.
The nymph was, no doubt, of a cold constitution;
For, sure, to turn tree was an odd resolution!
Yet in this she behav'd like a true modern spouse,
For she fled from his arms to distinguish his brows.

SECT. XII. *Of the Epitaph.*

173
Character
of the epi-
taph.

THESE compositions generally contain some eulogium of the virtues and good qualities of the deceased, and have a turn of seriousness and gravity adapted to the nature of the subject. Their elegance consists in a nervous and expressive brevity; and sometimes they are closed with an epigrammatic point. In these compositions, no mere epithet (properly so called) should be admitted; for here illustration would impair the strength, and render the sentiment too diffuse and languid. Words that are synonymous are also to be rejected.

Though the true characteristic of the epitaph is seriousness and gravity, yet we may find many that are jocose and ludicrous: some likewise have true metre and rhyme; while others are between prose and verse, without any certain measure, though the words are truly poetical; and the beauty of this last sort is generally heightened by an apt and judicious antithesis. We shall give examples of each.

The following epitaph on Sir Philip Sydney's sister, the countess of Pembroke, said to be written by the famous Ben Jonson, is remarkable for the noble thought with which it concludes.

On MARY Countess-dowager of PEMBROKE.

Underneath this noble marble hearse,
Lies the subject of all verse,
Sidney's sister, Pembroke's mother:
Death, ere thou hast kill'd another
Fair, and learn'd, and good as she,
Time shall throw a dart at thee.

Take another epitaph of Ben Jonson's, on a beautiful and virtuous lady, which has been deservedly admired by very good judges.

Underneath this stone doth lie
As much virtue as could die;
Which when alive did vigour give
To as much beauty as could live.

The following epitaph by Dr Samuel Johnson, on a musician much celebrated for his performance, will bear a comparison with these, or perhaps with any thing of the kind in the English language.

Epitaph.

Philips! whose touch harmonious could remove
The pangs of guilty pow'r and hapless love,
Rest here, distressed by poverty no more;
Find here that calm thou gav'st so oft before;
Sleep undisturb'd within this peaceful shrine,
Till angels wake thee with a note like thine.

It is the just observation of an eminent critic, that the best subject for epitaphs is private virtue; virtue exerted in the same circumstances in which the bulk of mankind are placed, and which, therefore, may admit of many imitators. He that has delivered his country from oppression, or freed the world from ignorance and error, besides that he stands in no need of monumental panegyric, can excite the emulation of a very small number. The bare name of such men answers every purpose of a long inscription, because their achievements are universally known, and their fame is immortal. — But the virtues of him who has repelled the temptations of poverty, and disdained to free himself from distress at the expence of his honour or his conscience, as they were practised in private, are fit to be told, because they may animate multitudes to the same firmness of heart and steadiness of resolution. On this account, there are few epitaphs of more value than the following, which was written by Pope on Mrs Corbet, who died of a cancer in her breast.

Here rests a woman, good without pretence,
Blest with plain reason, and with sober sense:
No conquest she, but o'er herself desir'd;
No arts essay'd, but not to be admir'd.
Passion and pride were to her soul unknown,
Convinc'd that virtue only is our own.
So unaffected, so compos'd a mind,
So firm, yet soft, so strong, yet so refin'd,
Heav'n, as its purest gold, by tortures try'd;
The saint sustain'd it, but the woman dy'd.

This epitaph, as well as the second quoted from Ben Jonson, has indeed one fault; the name is omitted. The end of an epitaph is to convey some account of the dead; and to what purpose is any thing told of him whose name is concealed? The name, it is true, may be inscribed by itself upon the stone; but such a shift of the poet is like that of an unskilful painter, who is obliged to make his purpose known by adventitious help.

Amongst the epitaphs of a punning and ludicrous cast, we know of none prettier than that which is said to have been written by Mr Prior on himself, wherein he is pleasantly satirical upon the folly of those who value themselves upon account of the long series of ancestors through which they can trace their pedigree.

Nobles and heralds, by your leave,
Here lie the bones of Matthew Prior,
The son of Adam and of Eve:
Let Bourbon or Nassau go higher.

The following epitaph on a miser contains a good caution and an agreeable raillery.

Reader, beware immod'rate love of pelf:
Here lies the worst of thieves, who robb'd himself.

But Dr Swift's epitaph on the same subject is a masterpiece of the kind.

Beneath

174
Epitaphs
in verse,
with re-
marks up-
on them.

Beneath this verdant hillock lies
Demer, the wealthy and the wise.
His heirs, that he might safely rest,
Have put his carcase in a chest:
The very chest, in which, they say,
His other Self, his money, lay.
And if his heirs continue kind
To that dear self he left behind,
I dare believe that four in five
Will think his better half alive.

We shall give but one example more of this kind,
which is a merry epitaph on an old fiddler, who was
remarkable (we may suppose) for beating time to his
own music.

On STEPHEN the Fiddler.

Stephen and time are now both even;
Stephen beat time, now time's beat Stephen.

175
Epitaphs
in prose
eulogistic
and

We are come now to that sort of epitaph which re-
jects rhyme, and has no certain and determinate mea-
sure; but where the diction must be pure and strong,
every word have weight, and the antithesis be prefer-
red in a clear and direct opposition. We cannot give
a better example of this sort of epitaph than that on
the tomb of Mr Pulteney in the cloisters of Westmin-
ster-abbey.

Reader,

If thou art a BRITON,
Behold this Tomb with Reverence and Regret:
Here lie the Remains of

DANIEL PULTENEY,

The kindest Relation, the truest Friend,
The warmest Patriot, the worthiest Man.

He exercised Virtues in this Age,
Sufficient to have distinguish'd him even in the best.

Sagacious by Nature,

Industrious by Habit,

Inquisitive with Art;

He gain'd a complete Knowledge of the State of Britain,
Foreign and domestic;

In most the backward Fruit of tedious Experience,

In him the early acquisition of undissipated Youth.

He serv'd the Court several Years:

Abroad, in the auspicious Reign of Queen Anne;
At home, in the Reign of that excellent prince K. George I.

He serv'd his Country always,

At Court independent,

In the Senate unbiass'd,

At every Age, and in every Station:

This was the bent of his generous Soul,

This the business of his laborious Life.

Public Men, and Public Things,

He judg'd by one constant Standard,

The True Interest of Britain:

He made no other Distinction of Party,

He abhorred all other.

Gentle, humane, disinterested, beneficent,

He created no Enemies on his own Account:

Firm, determin'd, inflexible,

He feared none he could create in the Cause of Britain.

Reader,

In this Misfortune of thy Country lament thy own:

For know,

The Loss of so much private Virtue

Is a public calamity.

That poignant satire, as well as extravagant praise,
may be conveyed in this manner, will be seen by the
following epitaph written by Dr Arbuthnot on Fran-
cis Chartres; which is too well known, and too much
admired, to need our commendation.

HERE continueth to rot

The Body of FRANCIS CHARTRES,

Who with an INFLEXIBLE CONSTANCY,

And INIMITABLE UNIFORMITY of Life,

PERSISTED,

In spite of AGE and INFIRMITIES,

In the Practice of EVERY HUMAN VICE,

Excepting PRODIGALITY and HYPOCRISY:

His insatiable AVARICE exempted him from the first,

His matchless IMPUDENCE from the second.

Nor was he more singular

In the undeviating *Pravity* of his *Manners*,

Than successful

In *Accumulating WEALTH*:

For, without TRADE or PROFESSION,

Without TRUST of PUBLIC MONEY,

And without BRIBE-WORTHY Service,

He acquired, or more properly created,

A MINISTERIAL ESTATE.

He was the only Person of his Time

Who could CHEAT without the Mask of HONESTY

Retain his Primæval MEANNESS

When possessed of TEN THOUSAND a-year;

And having daily deserved the GIBBET for what he *did*,

Was at last condemn'd to it for what he *could* not do.

Oh indignant reader!

Think not his Life useless to Mankind;

PROVIDENCE conniv'd at his execrable designs,

To give to After-ages

A conspicuous PROOF and EXAMPLE

Of how small Estimation is EXORBITANT WEALTH

In the Sight of GOD,

By His bestowing it on the most UNWORTHY of ALL

MORTALS.

We shall conclude this species of poetry with a droll
and satirical epitaph written by Mr Pope, which we
transcribed from a monument in Lord Cobham's gardens
at Stow in Buckinghamshire.

To the Memory

of

SIGNIOR FIDO;

An *Italian* of good extraction;

Who came into *England*,

Not to bite us, like most of his Countrymen,

But to gain an honest Livelihood.

He hunted not after Fame,

Yet acquir'd it;

Regardless of the Praise of his Friends,

But most sensible of their Love,

Though he liv'd amongst the Great,

He neither learnt nor flatter'd any Vice.

He was no Bigot,

Though he doubted of none of the 39 Articles.

And, if to follow Nature,

And to respect the laws of Society,

Be Philosophy,

He was a perfect Philosopher,

A faithful Friend,

An agreeable Companion,

A loving Husband,
Distinguish'd by a numerous offspring,
All which he liv'd to see take good Courses.
In his old Age he retired
To the house of a Clergyman in the country,
Where he finished his earthly Race,
And died an Honour and an Example to the whole Species.

Reader,
This Stone is guiltless of Flattery;
For he to whom it is inscrib'd
Was not a MAN,
But a
GRE-HOUND.

PART III. ON VERSIFICATION.

ON this subject it is meant to confine our inquiry to Latin or Greek hexameters, and to French and English heroic verse; as the observations we shall have occasion to make, may, with proper variations, be easily transferred to the composition of other sorts of verse.

177
Essentials
of verse.

Before entering upon particulars, it must be premised in general, that to verse of every kind five things are of importance. 1st, The number of syllables that compose a line. 2d, The different lengths of syllables, *i.e.* the difference of time taken in pronouncing. 3d, The arrangement of these syllables combined in words. 4th, The pauses or stops in pronouncing. 5th, Pronouncing syllables in a high or a low tone. The three first mentioned are obviously essential to verse: if any of them be wanting, there cannot be that higher degree of melody which distinguisheth verse from prose. To give a just notion of the fourth, it must be observed, that pauses are necessary for three different purposes: one, to separate periods, and members of the same period, according to the sense: another, to improve the melody of verse: and the last, to afford opportunity for drawing breath in reading. A pause of the first kind is variable, being long or short, frequent or less frequent, as the sense requires. A pause of the second kind, being determined by the melody, is in no degree arbitrary. The last sort is in a measure arbitrary, depending on the reader's command of breath. But as one cannot read with grace, unless, for drawing breath, opportunity be taken of a pause in the sense or in the melody, this pause ought never to be distinguished from the others; and for that reason shall be laid aside. With respect then to the pauses of sense and of melody, it may be affirmed without hesitation, that their coincidence in verse is a capital beauty: but as it cannot be expected, in a long work especially, that every line should be so perfect; we shall afterward have occasion to see, that, unless the reader be uncommonly skilful, the pause necessary for the sense must often, in some degree, be sacrificed to the verse-pause, and the latter sometimes to the former.

178
Regulation
of pauses

The pronouncing syllables in a high or low tone contributes also to melody. In reading, whether verse or prose, a certain tone is assumed, which may be called the *key-note*; and in that tone the bulk of the words are founded. Sometimes to humour the sense, and sometimes the melody, a particular syllable is founded in a higher tone, and this is termed *accenting a syllable*, or gracing it with an accent. Opposed to the accent is the cadence, which, however, being entirely regulated by the sense, hath no peculiar relation to verse. The cadence is a falling of the voice below the key-note at the close of every period; and so little is it essential to verse, that in correct reading the final syllable of every line is accented, that syllable only excepted which closes the period, where the sense requires a cadence.

Though the five requisites above mentioned enter the composition of every species of verse, they are however governed by different rules, peculiar to each species.

Upon quantity only, one general observation may be premised, because it is applicable to every species of verse. That syllables, with respect to the time taken in pronouncing, are long or short; two short syllables, with respect to time, being precisely equal to a long one. These two lengths are essential to verse of all kinds; and to no verse, it is believed, is a greater variety of time necessary in pronouncing syllables. The voice indeed is frequently made to rest longer than usual upon a word that bears an important signification; but this is done to humour the sense, and is not necessary for melody. A thing not more necessary for melody occurs with respect to accenting, similar to that now mentioned: A word signifying any thing humble, low, or dejected, is naturally, in prose as well as in verse, pronounced in a tone below the key-note.

179
Quantity.

We are now sufficiently prepared for particulars; beginning with Latin or Greek hexameter, which are the same. The observations upon this species of verse will come under the four following heads; number, arrangement, pause, and accent; for as to quantity, what is observed above may suffice.

I. HEXAMETER LINES, as to time, are all of the same length; being equivalent to the time taken in pronouncing twelve long syllables or twenty-four short. An hexameter line may consist of seventeen syllables; and when regular and not spondaic it never has fewer than thirteen: whence it follows, that where the syllables are many, the plurality must be short; where few, the plurality must be long.

180

This line is susceptible of much variety as to the succession of long and short syllables. It is, however, subjected to laws that confine its variety within certain limits: and for ascertaining these limits, grammarians have invented a rule by dactyles and spondees, which they denominate *feet*.

Among the ancient Greeks and Romans, these feet regulated the pronunciation, which they are far from doing among us; of which the reason will be discovered from the explanation that we shall give of the English accent. We shall at present content ourselves with pointing out the difference between our pronunciation and that of the Romans in the first line of Virgil's eclogues, where it is scarcely credible how much we perturb the quantity.

Tit'yre tú pat'ulæ rec'ubans sub teg'mine fâgi.

It will be acknowledged by every reader who has an ear, that we have placed the accentual marks upon every syllable, and the letter of every syllable, that an Englishman

Verifica-
tion.Verifica-
tion.

lishman marks with the *iſus* of his voice when he recites the line. But, as will be ſeen preſently, a ſyllable which is pronounced with the ſtreſs of the voice upon a conſonant is uttered in the ſhorteſt time poſſible. Hence it follows, that in this verſe, as recited by us, there are but two long ſyllables, *tú* and *fá*; though it is certain, that, as recited by a Roman, it contained no fewer than eight long ſyllables.

Títýrē | tú pátū|lāē rēcū|bāns fūb | tēgmīnē | fāgī.

But though to pronounce it in this manner with the voice dwelling on the vowel of each long ſyllable would undoubtedly be correct, and preſerve the true movement of the verſe, yet to an Engliſh ear, prejudiced in behalf of a different movement, it ſounds ſo very uncouth, that Lord Kames has pronounced the true feet of the Greek and Roman verſes extremely artificial and complex; and has ſubſtituted in their ſtead the following rules, which he thinks more ſimple and of more eaſy application. 1ſt, The line muſt always commence with a long ſyllable, and cloſe with two long preceded by two ſhort. 2d, More than two ſhort can never be found together, nor fewer than two. And, 3d, Two long ſyllables which have been preceded by two ſhort cannot alſo be followed by two ſhort. Theſe few rules fulfil all the conditions of a hexameter line with relation to order or arrangement. For theſe again a ſingle rule may be ſubſtituted, which has alſo the advantage of regulating more affirmatively the conſtruction of every part. To put this rule into words with perſpicuity, a hint is taken from the twelve long ſyllables that compoſe an hexameter line, to divide it into twelve equal parts or portions, being each of them one long ſyllable or two ſhort. The rule then is: “The 1ſt, 3d, 5th, 7th, 9th, 11th, and 12th portions, muſt each of them be one long ſyllable; the 10th muſt always be two ſhort ſyllables; the 2d, 4th, 6th, and 8th, may either be one long or two ſhort.” Or to expreſs the thing ſtill more ſhortly, “The 2d, 4th, 6th, and 8th portions may be one long ſyllable or two ſhort; the 10th muſt be two ſhort ſyllables; all the reſt muſt conſiſt each of one long ſyllable.” This fulfils all the conditions of an hexameter line, and comprehends all the combinations of daſtyles and ſpondees that this line admits.

Elem. of
Criticiſm.
ch. xviii.
ſect. 4.181
Pauses in
hexameter
considered
with re-
spect to
melody and

Next in order comes the pauſe. At the end of every hexameter line, every one muſt be ſenſible of a complete cloſe or full pauſe; the cauſe of which follows. The two long ſyllables preceded by two ſhort, which always cloſe an hexameter line, are a fine preparation for a pauſe: for long ſyllables, or ſyllables pronounced ſlow, reſembling a ſlow and languid motion tending to reſt, naturally incline the mind to reſt, or, which is the ſame, to pauſe; and to this inclination the two preceding ſhort ſyllables contribute, which, by contraſt, make the ſlow pronunciation of the final ſyllables the more conſpicious. Beſide this complete cloſe or full pauſe at the end, others are alſo requiſite for the ſake of melody; of which two are clearly diſcoverable, and perhaps there may be more. The longeſt and moſt remarkable ſucceeds the 5th portion: the other, which, being ſhorter and more faint, may be called the *ſemipauſe*, ſucceeds the 8th portion. So ſtriking is the pauſe firſt mentioned, as to be diſtinguiſhed even by the rudeſt ear: the monkish rhymes are evidently built upon it; in which, by an invariable

rule, the final word always chimes with that which immediately precedes the pauſe:

De planctu cudo || metrum cum carmine nudo
Mingere cum bumbis || res eſt ſaluberrima lumbis.

The difference of time in the pauſe and ſemipauſe occaſions another difference not leſs remarkable; that it is lawful to divide a word by a ſemipauſe, but never by a pauſe, the bad effect of which is ſenſibly felt in the following examples:

Effuſus labor, at||que inmitis rupta Tyranni
Again:

Obſervans nido in||plumes detraxit; at illa
Again:

Loricam quam De||moleo detraxerat ipſe

The dividing a word by a ſemipauſe has not the ſame bad effect:

Jamque pedem referens || caſus e|vaſerat omnes.
Again:

Qualis populea || mœrens Philo|mela ſub umbra
Again:

Ludere que vellem || calamo per|mifit agreſti.

Lines, however, where words are left entire, without being divided even by a ſemipauſe, run by that means much the more ſweetly.

Nec gemere aërea || ceſſabit | turtur ab ulmo.
Again:

Quadrupedante putrem || ſonitu quatit | ungula campum.
Again:

Eurydicen toto || reſerebant | flumine ripæ.

The reaſon of theſe obſervations will be evident upon the ſlighteſt reflection. Between things ſo intimately connected in reading aloud as are ſenſe and ſound, every degree of diſcord is unpleaſant: and for that reaſon it is a matter of importance to make the muſical pauses coincide as much as poſſible with thoſe of ſenſe; which is requiſite more eſpecially with reſpect to the pauſe, a deviation from the rule being leſs remarkable in a ſemipauſe. Conſidering the matter as to melody ſolely, it is indifferent whether the pauses be at the end of words or in the middle; but when we carry the ſenſe along, it is diſagreeable to find a word ſplit into two by a pauſe, as if there were really two words: and though the diſagreeableneſs here be connected with the ſenſe only, it is by an eaſy tranſition of perceptions transferred to the ſound; by which means we conceive a line to be harſh and grating to the ear, when in reality it is only ſo to the underſtanding.

To the rule that fixes the pauſe after the 5th portion there is one exception and no more. If the ſyllable ſucceeding the 5th portion be ſhort, the pauſe is ſometimes poſtponed to it:

Pupillis quos dura || premit cuſtodia matrum
Again:

In terras oppreſſa || gravi ſub religione

Again:

Et quorum pars magna || fui; quis talia ſando

This contributes to diverſify the melody; and, where the words are ſmooth and liquid, is not ungraceful; as in the following examples:

Formoſam

Verifica-
tion.

Formosam resonare || doces Amaryllida sylvæ

Again:

Agricolæ, quibus ipsa || procul discordibus armis

If this pause, placed as aforesaid after the short syllable, happen also to divide a word, the melody by these circumstances is totally annihilated. Witness the following line of Ennius, which is plain prose:

Romæ mœnia terræ || it impiger | Hannibal armis.

182
Sense.

Hitherto the arrangement of the long and short syllables of an hexameter line and its different pauses have been considered with respect to melody: but to have a just notion of hexameter verse, these particulars must also be considered with respect to sense. There is not perhaps in any other sort of verse such latitude in the long and short syllables; a circumstance that contributes greatly to that richness of melody which is remarkable in hexameter verse, and which made Aristotle pronounce that an epic poem in any other verse would not succeed*. One defect, however, must not be dissimulated, that the same means which contribute to the richness of the melody render it less fit than several other sorts for a narrative poem. There cannot be a more artful contrivance, as above observed, than to close an hexameter line with two long syllables preceded by two short: but unhappily this construction proves a great embarrassment to the sense; which will thus be evident. As in general there ought to be a strict concordance between the thought and the words in which it is dressed; so, in particular, every close in the sense ought to be accompanied with a close in the sound. In prose this law may be strictly observed, but in verse the same strictness would occasion insuperable difficulties. Willing to sacrifice to the melody of verse some share of the concordance between thought and expression, we freely excuse the separation of the musical pause from that of the sense during the course of a line; but the close of an hexameter line is too conspicuous to admit this liberty: for which reason there ought always to be some pause in the sense at the end of every hexameter line, were it but such a pause as is marked by a comma; and for the same reason there ought never to be a full close in the sense but at the end of a line, because there the melody is closed. An hexameter line, to preserve its melody, cannot well admit any great relaxation; and yet, in a narrative poem, it is extremely difficult to adhere strictly to the rule even with these indulgences. Virgil, the chief of poets for versification, is forced often to end a line without any close in the sense, and as often to close the sense during the running of a line; though a close in the melody during the movement of the thought, or a close in the thought during the movement of the melody, cannot be agreeable.

183
Observations on the
accent.

The accent, to which we proceed, is not less essential than the other circumstances above handled. By a good ear it will be discerned, that in every line there is one syllable distinguishable from the rest by a capital accent: That syllable, being the seventh portion, is invariably long

Nec bene promeritis || capitur nec | tangitur ira
Again:

Non sibi sed toto || genitum se | credere mundo
Again:

Qualis spelunca || subitò com|motâ columba

In these examples the accent is laid upon the last syllable of a word; which is favourable to the melody in the following respect, that the pause, which for the sake of reading distinctly must follow every word, gives opportunity to prolong the accent. And for that reason, a line thus accented has a more spirited air than when the accent is placed on any other syllable. Compare the foregoing lines with the following.

Verifica-
tion

Alba neque Assyrio || fuerat | lana veneno

Again:

Panditur interea || domus omnipo|tentis Olympi

Again:

Olli sedato || respondit | corde Latinus.

In lines where the pause comes after the short syllable succeeding the 5th portion, the accent is displaced, and rendered less sensible: it seems to be split into two, and to be laid partly on the 5th portion, and partly on the 7th, its usual place; as in

Nuda genu, nodòque || finis col|lecta fluentes.

Again:

Formosam resonare || doces Amaryllida sylvæ.

Beside this capital accent, slighter accents are laid upon other portions; particularly upon the 4th, unless where it consists of two short syllables; upon the 9th, which is always a long syllable; and upon the 11th, where the line concludes with a monosyllable. Such conclusion, by the by, impairs the melody, and for that reason is not to be indulged unless where it is expressive of the sense. The following lines are marked with all the accents.

Ludere quæ vellent calamò permittit agresti

Again:

Et duræ quærens sudabunt roseida mella

Again:

Parturiunt montes, nascitur ridiculus mus.

Reflecting upon the melody of hexameter verse, we find, that order or arrangement doth not constitute the whole of it: for when we compare different lines, equally regular as to the succession of long and short syllables, the melody is found in very different degrees of perfection; which is not occasioned by any particular combination of dactyles and spondees, or of long and short syllables, because we find lines where dactyles prevail, and lines where spondees prevail, equally melodious. Of the former take the following instance:

Æneadum genitrix hominum divumque voluptas.
Of the latter:

Molli paulatim flavescent campus arista.

What can be more different as to melody than the two following lines, which, however, as to the succession of long and short syllables, are constructed precisely in the same manner?

Spond. Dact. Spond. Spond. Dact. Spond.

Ad talos stola dimissa et circumdata palla. Hor.

Spond. Dact. Spond. Spond. Dact. Spond.

Placatumque nitet diffuso lumine cælum. Lucret.

In the former, the pause falls in the middle of a word, which is a great blemish, and the accent is disturbed by a harsh elision of the vowel *a* upon the particle *et*. In the latter, the pauses and the accent are all of them distinct

Verifica-
tion.

distinct and full: there is no elision: and the words are more liquid and sounding. In these particulars consists the beauty of an hexameter line with respect to melody; and by neglecting these, many lines in the fables and epistles of Horace are less agreeable than plain prose; for they are neither the one nor the other in perfection. To draw melody from these lines, they must be pronounced without relation to the sense: it must not be regarded that words are divided by pauses, nor that harsh elisions are multiplied. To add to the account, prosaic low-sounding words are introduced; and, which is still worse, accents are laid on them. Of such faulty lines take the following instances.

Candida rectaque sit, munda hastenus sit neque longa.

Jupiter exclamat simul atque audirit; at in fe

Cultodes, lectica, ciniflones, parasitæ

Optimus est modulator, ut Alfenus Vafer omni

Nunc illud tantum queram, meritone tibi sit.

These observations on pauses and semi-pauses, and on the structure of an hexameter line, are doubtless ingenious; but it is by no means certain that a strict attention to them would assist any man in the writing of such verses as would have been pleasing to a Roman ear. Many of his Lordship's rules have no other foundation than what rests on our improper mode of accenting Latin words; which to Virgil or Lucretius would probably have been as offensive as the Scotch accent is to a native of Middlesex.

II. Next in order comes ENGLISH HEROIC VERSE; which shall be examined under the heads of *number*, *accent*, *quantity*, *movement*, and *pause*. These have been treated in so clear and masterly a manner by Sheridan in his *Art of Reading*, that we shall have little more to do than abridge his doctrine, and point out the few instances in which attachment to a system and partiality to his native tongue seem to have betrayed him into error, or at least made him carry to an extreme what is just only when used with moderation.

"Numbers, in the strict sense of the word*, whether with regard to poetry or music, consist in certain impressions made on the ear at stated and regular distances. The lowest species of numbers is a *double stroke* of the same note or sound, repeated a certain number of times, at equal distances. The repetition of the same *single note* in a continued series, and exactly at equal distances, like the tickling of a clock, has in it nothing numerous; but the same note, *twice struck* a certain number of times, with a pause between each *repetition* of double the time of that between the *strokes*, is numerous. The reason is, that the pleasure arising from *numbers*, consists in the observation of *proportion*; now the repetition of the same note, in exactly the *same intervals*, will admit of no proportion. But the same note *twice struck*, with the pause of *one* between the two strokes, and repeated again at the distance of a pause equal to *two*, admits of the proportional measurement in the pauses of *two* to *one*, to which time can be beaten, and is the lowest and simplest species of numbers. It may be exemplified on the drum, as tu'm-tu'm--tu'm-tu'm--tu'm-tu'm, &c.

"The next progression of numbers is, when the same note is repeated, but in such a way as that one makes a

Vol. XV. Part I.

Verifica-
tion.

more sensible impression on the ear than the other, by being more forcibly struck, and therefore having a greater degree of loudness; as ti-tu'm--ti-tu'm; or, tu'm-ti--tu'm-ti: or when two weak notes precede a more forcible one, as ti-ti-tu'm--ti-ti-tu'm; or when the weak notes follow the forcible one, tu'm-ti-ti--tu'm-ti-ti.

"In the first and lowest species of numbers which we have mentioned, as the notes are exactly the same in every respect, there can be no proportion observed but in the time of the pauses. In the second, which rises in a degree just above the other, though the notes are still the same, yet there is a diversity to be observed in their respective loudness and softness, and therefore a measurable proportion of the quantity of sound. In them we must likewise take into consideration the order of the notes, whether they proceed from strong to weak, or from weak to strong; for this diversity of order occasions a great difference in the impressions made upon the ear, and in the effects produced upon the mind. To express the diversity of order in the notes in all its several kinds, the common term *movement* may be used, as the term *measure* will properly enough express the different proportions of time both in the pauses and in the notes."

For it is to be observed, that all notes are not of the same length or on the same key. In poetry, as well as in music, notes may be high or low, flat or sharp; and some of them may be prolonged at pleasure. "Poetic numbers are indeed founded upon the very same principles with those of the musical kind, and are governed by similar laws (see MUSIC). Proportion and order are the sources of the pleasure which we receive from both; and the beauty of each depends upon a due observation of the laws of measure and movement. The essential difference between them is, that the matter of the one is articulate, that of the other inarticulate sounds: but syllables in the one correspond to notes in the other; poetic feet to musical bars; and verses to strains; in a word, they have all like properties, and are governed by laws of the same kind.

"From what has been said, it is evident, that the *essence* of numbers consists in certain impressions made on the mind through the ear at stated and regular distances of time, with an observation of a relative proportion in those distances; and that the other circumstances of long or short in syllables, or diversity of notes in uttering them, are *not* essentials but only *accidents* of poetic numbers. Should this be questioned, the objector might be silenced by having the experiment tried on a drum, on which, although it is incapable of producing long or short, high or low notes, there is no kind of metre which may not be beat. That, therefore, which regulates the series and movement of the impressions given to the ear by the recitation of an English verse, must, when properly disposed, constitute the essence of English poetic numbers; but it is the accent which particularly impresses the sound of certain syllables or letters upon the ear; for in every word there is a syllable or letter accented. The necessity and use of the accent, as well in prose as in verse, we shall therefore proceed to explain.

"As words may be formed of various numbers of syllables, from one up to eight or nine*, it was necessary that there should be some peculiar mark to distin-

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* Art of
Reading,
vol. ii.

Versifica-
tion.

guish words from disjointed syllables, otherwise speech would be nothing but a continued succession of syllables conveying no ideas. This distinction of one word from another might be made by a perceptible pause at the end of each in speaking, analogous to the distance made between them in writing and in printing. But these pauses would make discourse disgustingly tedious; and though they might render words sufficiently distinct, they would make the meaning of sentences extremely confused. Words might also be distinguished from each other, and from a collection of detached syllables, by an *elevation* or *depression* of the voice upon one syllable of each word; and this, as is well known to the learned, was the practice of the Greeks and Romans. But the English tongue has for this purpose adopted a mark of the easiest and simplest kind, which is called *accent*. By accent is meant, a certain stress of the voice, upon a particular letter of a syllable, which distinguishes it from the rest, and at the same time distinguishes the syllable itself to which it belongs from the other syllables which compose the word. Thus, in the word *hab'it*, the accent upon the *b* distinguishes that letter from the others, and the first syllable from the last; add more syllables to it, and it will still do the same, as *hab'itable*. In the word *accept*, the *p* is the distinguished letter, and the syllable which contains it the distinguished syllable; but if we add more syllables to it, as in the word *ac'ceptable*, the seat of the accent is changed to the first syllable, of which *c* is the distinguished letter. Every word in our language of more syllables than one has one of the syllables distinguished from the rest in this manner, and every monosyllable has a letter. Thus, in the word *bat* the *t* is accented, in *hâte* the vowel *a*, in *cub'* the *b*, and in *cûbe* the *u*: so that as articulation is the essence of syllables, accent is the essence of words; which without it would be nothing more than a mere succession of syllables."

We have said, that it was the practice of the Greeks and Romans to elevate or depress their voice upon one syllable of each word. In this elevation or depression consisted their accent; but the English accent consists in the mere stress of the voice, without any change of note. "Among the Greeks, all syllables were pronounced either in a high, low, or middle note; or else in a union of the high and low by means of the intermediate. The middle note, which was exactly at an equal distance between the high and the low, was that in which the unaccented syllables were pronounced. But every word had one letter, if a monosyllable; or one syllable, if it consisted of more than one, distinguished from the rest; either by a note of the voice perceptibly higher than the middle note, which was called the *acute accent*; or by a note perceptibly, and in an equal proportion, lower than the middle one, which was called the *grave accent*; or by an union of the acute and grave on one syllable, which was done by the voice passing from the acute, through the middle note, in continuity down to the grave, which was called the *circumflex*."

"Now in pronouncing English words, it is true that one syllable is always distinguished from the rest, but it is not by any perceptible elevation or depression of the voice, any high or low note, that it is done, but merely by dwelling longer upon it, or by giving it a more forcible stroke. When the stress or accent is on

the vowel, we dwell longer on that syllable than on the rest; as, in the words *glôry*, *faîber*, *bôly*. When it is on the consonant, the voice, passing rapidly over the vowel, gives a snarter stroke to the consonant, which distinguishes that syllable from others, as in the words *bat'tle*, *hab'it*, *bar'row*."

Having treated so largely of *accent* and *quantity*, the next thing to be considered in verse will be quickly discussed; for in English it depends wholly on the seat of the accent. "When the accent or stress is on the vowel, the syllable is necessarily long, because the accent cannot be made without dwelling on the vowel a longer time than usual. When it is on the consonant, the syllable is short; because the accent is made by passing rapidly over the vowel, and giving a smart stroke of the voice to the following consonant. Thus the words *ad'd*, *led'*, *bid'*, *cub'*, are all short, the voice passing quickly over the vowel to the consonant; but for the contrary reason, the words *âll*, *lâid*, *bîde*, *cûbe*, are long; the accent being on the vowels, on which the voice dwells some time before it takes in the sound of the consonant."

"Obvious as this point is, it has wholly escaped the observation of many an ingenious and learned writer. Lord Kames affirms*, that accenting is confined in English heroic verse to the long syllables; for a short syllable (says he) is not capable of an accent: and Dr Forster, who ought to have understood the nature of the English accent better than his Lordship, asks, whether we do not 'employ more time in uttering the first syllables of *heavily*, *basily*, *quickly*, *slowly*; and the second in *solicit*, *mistaking*, *researches*, *delusive*, than in the others?" To this question Mr Sheridan replies†, that "in some of these words we certainly do as the Doctor supposes; in *basily*, *slowly*, *mistaking*, *delusive*, for instance; where the accent being on the vowels renders their sound long: but in all the others, *heav'ily*, *quick'ly*, *solis'-it*, *re-fear'-ches*, where the accent is on the consonant, the syllables *heav'*, *quick'*, *lis'-er*, are pronounced as rapidly as possible, and the vowels are all short. In the Scotch pronunciation (continues he) they would indeed be all reduced to an equal quantity, as thus; *hâi-vily*, *hâis-tily*, *quêek-ly*, *slôw-ly*, *so-léc-cit*, *re-fâir'-ches*, *de-lû-sive*. But here we see that the four short syllables are changed into four long ones of a different sound, occasioned by their placing the seat of the accent on the vowels instead of the consonants: thus instead of *heav'* they say *hâiv*; for *quick'*, *quêek*; for *lis'*, *lêee*; and for *ser'*, *saîr*."

"It appears therefore, that the quantity of English syllables is adjusted by one easy and simple rule; which is, that when the seat of the accent is on a vowel, the syllable is long; when on a consonant, short; and that all unaccented syllables are short. Without a due observation of quantity in reciting verses there will be no poetic numbers; yet in composing English verses the poet need not pay the least attention to the quantity of his syllables, as measure and movement will result from the observation of other laws, which are now to be explained."

It has been affirmed by a writer* of great authority • Lord among the critics, that in English heroic verse every line consists of ten syllables, five short and five long; from which there are but two exceptions, both of them rare.

Versifica-
tion.* *El. of Crit.* vol. ii.† *Art of Reading*, vol. ii.

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tion.Verifica-
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tion. rare. The first is, where each line of a couplet is made eleven syllables, by an additional short syllable at the end.

Thère heroes wit's are kept in pond'rous vases,
And beaux' in snuff-boxes and tweezer-cases.

The other exception, he says, concerns the second line of a couplet, which is sometimes stretched out to twelve syllables, termed an *Alexandrine line*.

A needless Alexandrine ends the song,
That, like a wounded snake, drags its flow length
along.

After what has been just said, it is needless to stop for the purpose of pointing out the ingenious author's mistake respecting long and short syllables. Every attentive reader of what has been already laid down, must perceive, that in the first line of the former couplet, though there are no fewer than six accented syllables when it is properly read, yet of these there are but three that are long, *viz.* those which have the accent on the vowel. Our business at present is, to show the falsity of the rule which restrains the heroic line to ten syllables; and this we shall do by producing lines of a greater number.

And the shrill sounds ran echoing through the wood.

This line, though it consists of eleven syllables, and has the last of those accented, or, as Lord Kames would say, long, is yet undoubtedly a heroic verse of very fine sound. Perhaps the advocates for the rule may contend, that the vowel *o* in echoing ought to be struck out by an apostrophe; but as no one reads,

And the shrill sounds ran ech'ing through the wood,
it is surely very absurd to omit in writing what cannot be omitted in utterance. The two following lines have each eleven syllables, of which not one can be suppressed in recitation.

Their glittering textures of the filmy dew,
The great hierarchal standard was to move.

Mr Sheridan quotes as a heroic line,

O'er many a frozen, many a fiery Alp;

and observes what a monstrous line it would appear, if pronounced,

O'er man' a frozen, man' a fiery Alp,

instead of that noble verse, which it certainly is, when all the thirteen syllables are distinctly uttered. He then produces a couplet, of which the former line has fourteen, and the latter twelve syllables.

And many an amorous, many a humorous lay,
Which many a bard had chaunted many a day.

That this is a couplet of very fine sound cannot be controverted; but we doubt whether the numbers of it or of the other quoted line of thirteen syllables be truly heroic. To our ears at least there appears a very perceptible difference between the movement of these verses and that of the verses of Pope or Dryden; and we think, that, though such couplets or single lines may, for the sake of variety or expression, be admitted into a heroic poem, yet a poem wholly composed of them

would not be considered as heroic verse. It has a much greater resemblance to the verse of Spenser, which is now broke into two lines, of which the first has eight and the second six syllables. Nothing, however, seems to be more evident, from the other quoted instances, than that a heroic line is not confined to the syllables, and that it is not by the number of syllables that an English verse is to be measured.

But if a heroic verse in our tongue be not composed, as in French, of a certain number of syllables, how is it formed? We answer by feet, as was the hexameter line of the ancients; though between their feet and ours there is at the same time a great difference. The poetic feet of the Greeks and Romans are formed by quantity, those of the English by stress or accent. "Though these terms are in continual use, and in the mouths of all who treat of poetic numbers, very confused and erroneous ideas are sometimes annexed to them. Yet as the knowledge of the peculiar genius of our language with regard to poetic numbers and its characteristic difference from others in that respect, depends upon our having clear and precise notions of those terms, it will be necessary to have them fully explained. The general nature of them has been already sufficiently laid open, and we have now only to make some observations on their particular effects in the formation of metre.

"No scholar is ignorant that quantity is a term which relates to the length or the shortness of syllables, and that a long syllable is double the length of a short one. Now the plain meaning of this is, that a long syllable takes up double the time in sounding than a short one does; a fact of which the ear alone can be the judge. When a syllable in Latin ends with a consonant, and the subsequent syllable commences with one, every school-boy knows that the former is long, to use the technical term, by the law of *position*. This rule was in pronunciation strictly observed by the Romans, who always made such syllables long by dwelling on the vowels; whereas the very reverse is the case with us, because a quite contrary rule takes place in English words so constructed, as the accent or stress of the voice is in such cases always transferred to the consonant, and the preceding vowel being rapidly passed over, that syllable is of course short.

"The Romans had another rule of prosody, that when one syllable ending with a vowel, was followed by another beginning with a vowel, the former syllable was pronounced short; whereas in English there is generally an accent in that case on the former syllable, as in the word *pious*, which renders the syllable long. Pronouncing Latin therefore by our own rule, as in the former case, we make those syllables short which were sounded long by them; so in the latter, we make those syllables long which with them were short. We say *arma* and *virumque*, instead of *árma* and *virúmque*; *scio* and *tuus*, instead of *scíó* and *tuús*.

"Having made these preliminary observations, we proceed now to explain the nature of poetic feet. Feet in verse correspond to bars in music: a certain number of syllables connected form a foot in the one, as a certain number of notes make a bar in the other. They are called feet, because it is by their aid that the voice as it were steps along through the verse in a measured pace; and it is necessary that the syllables which mark this regular movement of the voice should in some

Verifica-
tion.

measure be distinguished from the others. This distinction, as we have already observed, was made among the ancient Romans, by dividing their syllables into long and short, and ascertaining their quantity by an exact proportion of time in sounding them; the long being to the short as two to one; and the long syllables, being thus the more important, marked the movement of the verse. In English, syllables are divided into accented and unaccented; and the accented syllables being as strongly distinguished from the unaccented, by the peculiar stress of the voice upon them, are as capable of marking the movement, and pointing out the regular paces of the voice, as the long syllables were by their quantity among the Romans. Hence it follows, that our accented syllables corresponding to their long ones, and our unaccented to their short, in the structure of poetic feet, an accented syllable followed by one unaccented in the same foot will answer to their *trochee*; and preceded by an unaccented one, to their *iambus*; and so with the rest.

"All feet used in poetry consist either of two or three syllables; and the feet among the ancients were denominated from the number and quantity of their syllables. The measure of quantity was the short syllable, and the long one in time was equal to two short. A foot could not consist of less than two times, because it must contain at least two syllables; and by a law respecting numbers, which is explained elsewhere (see Music), a poetic foot would admit of no more than four of those times. Consequently the poetic feet were necessarily reduced to eight; four of two syllables, and four of three. Those of two syllables must either consist of two short, called a *pyrrhic*; two long, called a *spondee*; a long and a short, called a *trochee*; or a short and a long, called an *iambus*. Those of three syllables were, either three short, a *tribrach*; a long and two short, a *dactyl*; a short, long, and short, an *amphibrach*; or two short and a long, an *anapaest* (x).

We are now sufficiently prepared for considering what feet enter into the composition of an English heroic verse.

The Greeks and Romans made use of but two feet in the structure of their hexameters; and the English heroic may be wholly composed of one foot, viz. the *iambic*, which is therefore the foot most congenial to that species of verse. Our poetry indeed abounds with verses into which no other foot is admitted. Such as,

The pow'rs | gave éar | and grán'ted hálf | his práy'r.
The rest' | the wínds | dispér's'd | in emp'ty áir.

Our heroic line, however, is not wholly restrained to the use of this foot. In the opinion of Mr Sheridan it admits all the eight before enumerated; and it certainly excludes none, unless perhaps the *tribrach*. It

is known to every reader of English poetry, that some of the finest heroic verses in our language begin with a *trochee*; and that Pope, the smoothest of all our versifiers, was remarkable for his use of this foot, as is evident from the following example, where four succeeding lines out of six have a trochaic beginning.

Her lively looks a sprightly mind disclose,
Quick as | her eyes | and as unfix'd as those:
Favours | to none | to all she smiles extends,
Oft she | rejects | but never once offends.
Bright as | the sun | her eyes the gazers strike,
And like the sun she shines on all alike.

The use of this foot, however, is not necessarily confined to the beginning of a line. Milton frequently introduces it into other parts of the verse; of which take the following instances:

That áll | was lost' | back' to | the thick'et slunk—
Of Eve | whose ey'e | darted contágious fire.

The last line of the following couplet begins with a *pyrrhic*:

She said, | and mélt'ing as in tears she lay,
In á | soft síl'ver stream dissolv'd away;

But this foot is introduced likewise with very good effect into other parts of the verse, as

Pánt on | thy lip' | and tó | thy héart | be prest.
The phantom flies me | ás únkind as you.
Leaps o'er the fence with ease | into | the fold.

And thè | shrill' sounds | ran echoing through the wood.

In this last line we see that the first foot is a *pyrrhic*, and the second a *spondee*; but in the next the two first feet are *spondees*.

Hill's péép | o'ér hill's | and Alps | on Alps | arise.

In the following verse a trochee is succeeded by two spondees, of which the former is a genuine spondee by quantity, and the latter equivalent to a spondee by accent.

Sée thè | bold yóuth | stráin up' | the threat'ning steep.

We shall now give some instances of lines containing both the *pyrrhic* and the *spondee*, and then proceed to the consideration of the other four feet.

Thát ön | wēāk wíngs | from far pursues your flight.

Thró' thè | fáir scēne | rōll slōw | the ling'ring streams.

On hēr | whítē breást | a sparkling cross she wore.

Of the four trissyllabic feet, the first, of which we shall give instances in heroic lines, is the *dactyl*; as

Murmuring, | and with | him' fled | the shades | of night.
Hovering

(x) For the convenience of the less learned reader we shall here subjoin a scheme of poetic feet, using the marks (- o) in use among the Latin grammarians to denote the genuine feet by quantity; and the following marks (' o) to denote the English feet by accent which answer to those.

	Roman	English
Trochee	- o	' o
Iambus	o -	o '
Spondee	- -	' '
Pyrrhic	o o	o o

	Roman	English
Dactyl	- o o	' o o
Amphibrach	o - o	o ' o
Anapaest	o o -	o o '
Tribrach	o o o	o o o

Verifica-
tion.

Verifica-
tion.

Hovering | on wing | un'der | the cape | of hell.
Tim'orous | and slothful yet he pleased the ear.
Of truth | in word | mightier | than they | in arms.
Of the *anapest* a single instance shall suffice; for except
by Milton it is not often used.

The great | hiérar|chal standard was to move.

The *amphibrach* is employed in the four following verses,
and in the three last with a very fine effect.

With wheels | yet hóvering o'er the ocean brim-
Rous'd from their slumber on | thát fiëry | couch.
While the | prômiscúous crowd stood yet aloof.
Throws his steep flight | in mán'y | ãn aĩry whirl.

Having thus sufficiently proved that the English heroic verse admits of all the feet except the *tribrach*, it may be proper to add, that from the nature of our accent we have duplicates of these feet, viz. such as are formed by quantity, and such as are formed by the mere *iëus* of the voice; an opulence peculiar to our tongue, and which may be the source of a boundless variety. But as feet formed of syllables which have the *accent* or *iëus* on the consonant are necessarily pronounced in less time than similar feet formed by quantity, it may be objected, that the measure of a whole line, constructed in the former manner, must be shorter than that of another line constructed in the latter; and that the intermixture of verses of such different measures in the same poem must have a bad effect on the melody, as being destructive of proportion. This objection would be well-founded, were not the time of the short accented syllables compensated by a small pause at the end of each word to which they belong, as is evident in the following verse:

Then rus'ling crack'ling crashing thun'der down.

This line is formed of iambs by accent upon consonants, except the last syllable; and yet by means of these soft pauses or rests, the measure of the whole is equal to that of the following, which consists of pure iambs by quantity.

O'er hēāps | of rūin stālk'd | the statel'y hīnd.

Movement, of so much importance in versification, regards the order of syllables in a foot, measure their quantity. The order of syllables respects their progress from short to long or from long to short, as in the Greek and Latin languages; or from strong to weak or weak to strong, *i. e.* from accented or unaccented syllables, as in our tongue. It has been already observed, that an English heroic verse may be composed wholly of iambs; and experience shows that such verses have a fine melody. But as the stress of the voice, in repeating verses of pure iambs, is regularly on every second syllable, such uniformity would disgust the ear in any long succession, and therefore such changes were sought for as might introduce the pleasure of variety without prejudice to melody; or which might even contribute to its improvement. Of this nature was the introduction of the trochee to form the first foot of an heroic verse, which experience has shown us is so far from spoiling the melody, that in many cases it heightens it. This foot, however, cannot well be admitted into any other part of the verse without prejudice to the melody, because it interrupts and stops the

usual movement by another directly opposite. But though it be excluded with regard to pure melody, it may often be admitted into any part of the verse with advantage to expression, as is well known to the readers of Milton.

"The next change admitted for the sake of variety, without prejudice to melody, is the intermixture of pyrrhics and spondees; in which two impressions in the one foot make up for the want of one in the other; and two long syllables compensate two short, so as to make the sum of the quantity of the two feet equal to two iambs. That this may be done without prejudice to the melody, take the following instances:

On hër | whīte brēāst | a sparkling cross she wore.—
Nōr thē | dēēp trāct | of hell—say first what cause.—

This intermixture may be employed *ad libitum*, in any part of the line; and sometimes two spondees may be placed together in one part of the verse, to be compensated by two pyrrhics in another; of which Mr Sheridan quotes the following lines as instances:

Stōōd rū'd | stōōd vāst | infīn|itūde | confined.
Shē āll | nīght lōng | hër āmō'rōus dēs|cant sung.

That the former is a proper example, will not perhaps be questioned; but the third foot in the latter is certainly no pyrrhic. As it is marked here and by him, it is a tribrach; but we appeal to our English readers, if it ought not to have been marked an amphibrach by accent, and if the fourth foot be not an iambus. To us the feet of the line appear to be as follow:

Shē āll | nīght lōng | hër āmō'rōus dēs|cant sung.

It is indeed a better example of the proper use of the amphibrach than any which he has given, unless perhaps the two following lines:

Up to | thē fiëry concave tow'ring high
Thrōws hīs | stēēp flīght | in mán'y | ãn aĩry whīrl.

That in these three lines the introduction of the amphibrach does not hurt the melody, will be acknowledged by every person who has an ear; and those who have not, are not qualified to judge. But we appeal to every man of taste, if the two amphibrachs succeeding each other in the last line do not add much to the expression of the verse. If this be questioned, we have only to change the movement to the common iambic, and we shall discover how feeble the line will become.

Throws hīs | steep flight | in many aĩry whirls.

This is simple description, instead of that magical power of numbers which to the imagination produces the object itself, *whirling* as it were round an axis.

Having thus shown that the iambus, spondee, pyrrhic, and amphibrach, by accent, may be used in our measure with great latitude; and that the trochee may at all times begin the line, and in some cases with advantage to the melody; it now remains only to add, that the dactyl, having the same movement, may be introduced in the place of the trochee; and the anapest in the place of the iambus. In proof of this, were not the article swelling in our hands, we could adduce many instances which would show what an inexhaustible fund of riches, and what an immense variety of materials, are prepared for us, "to build the lofty rhyme." But we hasten

Verifica-
tion.

hasten to the next thing to be considered in the art of versifying, which is known by the name of *pauses*.

"Of the poetic pauses there are two sorts, the *cesural* and the *final*. The *cesural* divides the verse into equal or unequal parts; the *final* closes it. In a verse there may be two or more *cesural* pauses, but it is evident that there can be but one *final*. As the *final* pause concerns the reader more than the writer of verses, it has been seldom treated of by the critics. Yet as it is this *final* pause which in many cases distinguishes verse from prose, it cannot be improper in the present article to show how it ought to be made. Were it indeed a law of our versification, that every line should terminate with a stop in the sense, the boundaries of the measure would be fixed, and the nature of the *final* pause could not be mistaken. But nothing has puzzled the bulk of readers, or divided their opinions, more than the manner in which those verses ought to be recited, where the sense does not close with the line; and whose last words have a necessary connection with those that begin the subsequent verse. "Some (says Mr Sheridan) who see the necessity of pointing out the metre, pronounce the last word of each line in such a note as usually accompanies a comma, in marking the smallest member of a sentence. Now this is certainly improper, because it makes that appear to be a complete member of a sentence which is an incomplete one; and by disjoining the sense as well as the words, often confounds the meaning. Others again, but these fewer in number, and of the more absurd kind, drop their voice at the end of every line, in the same note which they use in marking a full stop; to the utter annihilation of the sense. Some readers (continues our author) of a more enthusiastic kind, elevate their voices at the end of all verses to a higher note than is ever used in the stops which divide the meaning. But such a continued repetition of the same high note becomes disgusting by its monotony, and gives an air of chanting to such recitation. To avoid these several faults, the bulk of readers have chosen what they think a safer course, which is that of running the lines one into another without the least pause, where they find none in the sense; but by this mode of recitation they reduce poetry to something worse than prose, to verse run mad.

But it may be asked, if this *final* pause must be marked neither by an elevation nor by a depression of the voice, how is it to be marked at all? To which Mr Sheridan replies, by making no change whatever in the voice before it. This will sufficiently distinguish it from the other pauses, the comma, semicolon, &c. because some change of note, by raising or depressing the voice, always precedes them, whilst the voice is here only suspended.

Now this pause of suspension is the very thing wanting to preserve the melody at all times, without interfering with the sense. For it perfectly marks the bound of the metre: and being made only by a suspension, not by a change of note in the voice, it never can affect the sense; because the *sentential* stops, or those which affect the sense, being all made with a change of note, where there is no such change, the sense cannot be affected. Nor is this the only advantage gained to numbers by this stop of suspension. It also prevents the monotony at the end of lines; which, however pleasing to a rude, is disgusting to a delicate, ear. For as this stop has

no peculiar note of its own, but always takes that which belongs to the preceding word, it changes continually with the matter, and is as various as the sense.

Having said all that is necessary with regard to the *final*, we proceed now to consider the *cesural*, pause. To these two pauses it will be proper to give the denomination of *musical*, to distinguish them from the comma, semicolon, colon, and full stop, which may be called *sentential* pauses; the office of the former being to mark the melody, as that of the latter is to point out the sense. The *cesural*, like the *final* pause, sometimes coincides with the *sentential*; and sometimes takes place where there is no stop in the sense. In this last case, it is exactly of the same nature, and governed by the same laws with the pause of suspension, which we have just described.

The *cesure*, though not essential, is however a great ornament to verse, as it improves and diversifies the melody, by a judicious management in varying its situation; but it discharges a still more important office than this. Were there no *cesure*, verse could aspire to no higher ornament than that of simple melody; but by means of this pause there is a new source of delight opened in poetic numbers, correspondent in some sort to harmony in music. This takes its rise from that act of the mind which compares the relative proportions that the members of a verse thus divided bear to each other, as well as to those in the adjoining lines. In order to see this matter in a clear light, let us examine what effect the *cesure* produces in single lines, and afterwards in comparing contiguous lines with each other.

With regard to the place of the *cesure*, Mr Pope and others have expressly declared, that no line appeared musical to their ears, where the *cesure* was not after the fourth, fifth, or sixth syllable of the verse. Some have enlarged its empire to the third and seventh syllables; whilst others have asserted that it may be admitted into any part of the line.

"There needs but a little distinguishing (says Mr Sheridan) to reconcile these different opinions. If melody alone is to be considered, Mr Pope is in the right when he fixes its seat in or as near as may be to the middle of the verse. To form lines of the first melody, the *cesure* must either be at the end of the second or of the third foot, or in the middle of the third between the two. Of this movement take the following examples:

1. Of the *cesure* at the end of the second foot.

Our plenteous streams || a various race supply;
The bright-ey'd perch || with fins of Tyrian dye;
The silver eel || in shining volumes roll'd;
The yellow carp || in scales bedrop'd with gold.

2. At the end of the third foot.

With tender billet-doux || he lights the pyre,
And breathes three amorous sighs || to raise the fire.

3. Between the two, dividing the third foot.

The fields are ravish'd || from the industrious swains,
From men their cities, || and from gods their fanes.

These lines are certainly all of a fine melody, yet they are not quite upon an equality in that respect. Those which have the *cesure* in the middle are of the first order;

Verifica-
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der; those which have it at the end of the second foot are next; and those which have the pause at the end of the third foot the last. The reason of this preference it may not perhaps be difficult to assign.

In the pleasure arising from comparing the proportion which the parts of a whole bear to each other, the more easily and distinctly the mind perceives that proportion, the greater is the pleasure. Now there is nothing which the mind more instantaneously and clearly discerns, than the division of a whole into two equal parts, which alone would give a superiority to lines of the first order over those of the other two. But this is not the only claim to superiority which such lines possess. The cesure being in them always on an unaccented, and the final pause on an accented, syllable, they have a mixture of variety and equality of which neither of the other orders can boast, as in these orders the cesural and final pauses are both on accented syllables.

In the division of the other two species, if we respect quantity only, the proportion is exactly the same, the one being as two to three, and the other as three to two; but it is the order or movement which here makes the difference. In lines where the cesure bounds the second foot, the smaller portion of the verse is first in order, the greater last; and this order is reversed in lines which have the cesure at the end of the third foot. Now, as the latter part of the verse leaves the strongest and most lasting impression on the ear, where the larger portion belongs to the latter part of the line, the impression must in proportion be greater; the effect in sound being the same as that produced by a climax in sense, where one part rises above another.

Having shown in what manner the cesure improves and diversifies the melody of verse, we shall now treat of its more important office, by which it is the chief source of harmony in numbers. But, first, it will be necessary to explain what we mean by the term *harmony*; as applied to verse.

Melody in music regards only the effects produced by successive sounds; and harmony, strictly speaking, the effects produced by different co-existing sounds, which are found to be in concord. Harmony, therefore, in this sense of the word, can never be applied to poetic numbers, of which there can be only one reciter, and consequently the sounds can only be in succession. When therefore we speak of the harmony of verse, we mean nothing more than an effect produced by an action of the mind in comparing the different members of verse already constructed according to the laws of melody with each other, and perceiving a due and beautiful proportion between them.

The first and lowest perception of this kind of harmony arises from comparing two members of the same line with each other, divided in the manner to be seen in the three instances already given; because the beauty of proportion in the members, according to each of these divisions, is founded in nature. But there is a perception of harmony in versification, which arises from the comparison of two lines, and observing the relative proportion of their members; whether they correspond exactly to each other by similar divisions, as in the couplets already quoted; or whether they are diversified by cesures in different places. As,

See the bold youth || strain up the threatening steep,
Rush thro' the thickets || down the valleys sweep.

Where we find the cesure at the end of the second foot of the first line, and in the middle of the third foot of the last.

Hang o'er their courfers heads || with eager speed,
And earth rolls back || beneath the flying steed.

Here the cesure is at the end of the third foot in the former, and of the second in the latter line. — The perception of this species of harmony is far superior to the former; because, to the pleasure of comparing the members of the same line with each other, there is superadded that of comparing the different members of the different lines with each other; and the harmony is enriched by having four members of comparison instead of two. The pleasure is still increased in comparing a greater number of lines, and observing the relative proportion of the couplets to each other in point of similarity and diversity. As thus,

Thy forests, Windsor, || and thy green retreats,
At once the monarch's || and the muse's seats,
Invite my lays. || Be present sylvan maids,
Unlock your springs || and open all your shades.

Here we find that the cesure is in the middle of the verse in each line of the first couplet, and at the end of the second foot in each line of the last; which gives a similarity in each couplet distinctly considered, and a diversity when the one is compared with the other, that has a very pleasing effect. Nor is the pleasure less where we find a diversity in the lines of each couplet, and a similarity in comparing the couplets themselves. As in these,

Not half so swift || the trembling doves can fly,
When the fierce eagle || cleaves the liquid sky;
Not half so swiftly || the fierce eagle moves,
When thro' the clouds || he drives the trembling doves.

There is another mode of dividing lines well suited to the nature of the couplet, by introducing semipauses, which with the cesure divide the line into four portions. By a semipause, we mean a small rest of the voice, during a portion of time equal to half of that taken up by the cesure; as will be perceived in the following fine couplet:

Warms | in the sun || refreshes | in the breeze,
Glows | in the stars || and blossoms | in the trees.

That the harmony, and of course the pleasure, resulting from poetic numbers, is increased as well by the semipause as by the cesure, is obvious to every ear; because lines so constructed furnish a greater number of members for comparison: but it is of more importance to observe, that by means of the semipauses, lines which, separately considered, are not of the finest harmony, may yet produce it when opposed to each other, and compared in the couplet. Of the truth of this observation, the following couplet, especially as it succeeds that immediately quoted, is a striking proof:

Lives | thro' all life || extends | thro' all extent,
Spreads | undivided || operates | unspent.

What we have advanced upon this species of verse, will contribute to solve a poetical problem thrown out by Dryden as a crux to his brethren: it was to account for the peculiar beauty of that celebrated couplet in Sir John Denham's *Cooper's Hill*, where he thus describes the Thames:

Verifica-
tion.

Tho' deep | yet clear || tho' gentle | yet not dull.

Strong | without rage || without o'erflowing | full.

This description has great merit independent of the harmony of the numbers; but the chief beauty of the versification lies in the happy disposition of the pauses and semipauses, so as to make a fine harmony in each line when its portions are compared, and in the couplet when one line is compared with the other.

Having now said all that is necessary upon pauses and semipauses, we have done the utmost justice to our subject which the limits assigned us will permit. *Feet* and *pauses* are the constituent parts of verse; and the proper adjustment of them depends upon the poet's knowledge of *numbers*, *accent*, *quantity*, and *movement*, all of which we have endeavoured briefly to explain. In conformity to the practice of some critics, we might have treated separately of rhyme and of blank verse; but as the essentials of all heroic verses are the same,

such a division of our subject would have thrown no light upon the art of English versification. It may be just worth while to observe, that the pause at the end of a couplet ought to coincide, if possible, with a slight pause in the sense, and that there is no necessity for this coincidence of pauses at the end of any particular blank verse. We might likewise compare our heroic line with the ancient hexameter, and endeavour to appreciate their respective merits; but there is not a reader capable of attending to such a comparison who will not judge for himself; and it may perhaps be questioned, whether there be two who will form precisely the same judgment. Mr Sheridan, and all the mere English critics, give a high degree of preference to our heroic, on account of the vast variety of feet which it admits; whilst the readers of Greek and Latin poetry prefer the hexameter, on account of its more musical notes and majestic length.

Verifica-
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P O I

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Poictou.

POGGE, the CATAPHRACTUS COTTUS, in Ichthyology. See COTTUS, n° 2.

POGGIUS BRACCIOLINUS, a man of great parts and learning, who contributed much to the revival of knowledge in Europe, was born at Terranuova, in the territories of Florence, in 1380. His first public employment was that of writer of the apostolic letters, which he held 10 years, and was then made apostolic secretary, in which capacity he officiated 40 years, under seven popes. In 1453, when he was 72 years of age, he accepted the employment of secretary to the republic of Florence, to which place he removed, and died in 1459. He visited several countries, and searched many monasteries, to recover ancient authors, numbers of which he brought to light: his own works consist of moral pieces, orations, letters, and A History of Florence from 1350 to 1455, which is the most considerable of them.

POGO, is a name by which the inhabitants of the Philippine islands distinguish their quail, which, though smaller than ours, is in every other respect very like it.

POICTIERS, an ancient, large, and considerable town of France, capital of Poictou. It was a bishop's see, and contained four abbeys, a mint, an university famous for law, 22 parishes, 9 convents for men, and 12 nunneries. There are here several Roman antiquities, and particularly an amphitheatre, but partly demolished, and hid by the houses. There is also a triumphal arch, which serves as a gate to the great street. It is not peopled in proportion to its extent. Near this place Edward the Black Prince gained a decisive victory over the French, taking King John and his son Philip prisoners, in 1356, whom he afterwards brought over into England. See FRANCE, n° 71, &c.—It is seated on a hill on the river Clain, 52 miles south-west of Tours, and 120 north by east of Bourdeaux. E. Long. o. 25. N. Lat. 46. 35.

POICTOU, a province of France, bounded on the north by Bretagne, Anjou, and part of Touraine: on the east by Touraine, Berry, and Manche; on the south by Angoumois, Saintonge, and the territory of Aunis; and on the west by the sea of Gascony. It is divided

into the Upper and Lower; and is fertile in corn and wine, and feeds a great number of cattle, particularly mules. It was in possession of the kings of England for a considerable time, till it was lost by the unfortunate Henry VI. Poictiers is the capital town.

Colic of Poictou. See MEDICINE, n° 303.

POINCIANA, BARBADOES FLOWER-FENCE: A genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the 33d order, *Lomentaceæ*. The calyx is pentaphyllous; the petals five, the uppermost larger than the rest; the stamina long, and all fertile; the seed-vesel a legumen. There is only one species, viz. the pulcherrima, a native of both Indies. It rises with a straight stalk 10 or 12 feet high, which is covered with a grey bark, and is sometimes as thick as the small of a man's leg, dividing into several spreading branches at the top, which are armed at each joint with two short, crooked, strong spines, and garnished with decompound winged leaves, each leaf consisting of six or eight pair of simple winged leaves. They are of a light green colour, and when bruised emit a strong odour. The branches are terminated by loose spikes of flowers, which are sometimes formed into a kind of pyramid, and at others disposed more in the form of an umbel. The footstalk of each flower is near three inches long; the flower is composed of five petals, which are roundish at the top, but are contracted to narrow tails at the base. They spread open, and are beautifully variegated with a deep red or orange colour, yellow, and some spots of green; and emit a very agreeable odour. After the flower is past, the germen becomes a broad flat pod three inches long, divided into three or four cells by transverse partitions, each including one flattish irregular seed. The plant is propagated by seeds; but, being tender, is to be constantly kept in the bark-stove. It is very impatient of moisture in winter; and if the least damp seizes its top, it either kills the plant or destroys its head. With proper management it will grow taller here than in the places where it is native; but its stems will not be thicker than a man's finger. In Barbadoes it is planted in hedges to divide the lands, whence it has

Poictou,
Poinciana.

Point.

the name of *flower-fence*. In the West Indies, its leaves are made use of as a purge instead of senna; and in Jamaica it is called *sena*.

POINT, a term used in various arts.

POINT, in grammar, a character used to mark the divisions of discourse (See COMMA, COLON, &c.) A point proper is what we otherwise call a *full stop* or *period*. See PUNCTUATION.

POINT, in geometry, according to Euclid, is that which hath neither parts nor magnitude.

POINT, in music, a mark or note anciently used to distinguish the tones or sounds: hence we still call it *simple counter-point*, when a note of the lower part answers exactly to that of an upper; and *figurative counter-point*, when any note is syncopated, and one of the parts makes several notes or inflexions of the voice, while the other holds on one.

We still use a point, to raise the value of a note, and prolong its time by one half, *e. g.* a point added to a semibreve instead of two minims, make it equal to three; and so of the other notes. See the article TIME.

POINT, in astronomy, a term applied to certain points or places marked in the heavens, and distinguished by proper epithets.

The four grand points or divisions of the horizon, viz. the east, west, north, and south, are called the *cardinal points*.

The zenith and nadir are the vertical points; the points wherein the orbits of the planets cut the plane of the ecliptic are called the *nodes*: the points wherein the equator and ecliptic intersect are called the *equinoctial points*: particularly, that whence the sun ascends towards the north pole, is called the *vernal point*; and that by which he descends to the south pole, the *autumnal point*. The points of the ecliptic, where the sun's ascent above the equator, and descent below it, terminate, are called the *solstitial point*; particularly the former of them, the *estival* or *summer-point*; the latter, the *brumal* or *winter-point*.

POINT is also used for a cape or headland jutting out into the sea: thus seamen say, two points of land are in one another, when they are so in a right line against each other, as that the innermost is hindered from being seen by the outermost.

POINT, in perspective, is used for various poles or places, with regard to the perspective plane. See PERSPECTIVE.

POINT is also an iron or steel instrument, used with some variety in several arts. Engravers, etchers, cutters in wood, &c. use points to trace their designs on the copper, wood, stone, &c. See the articles ENGRAVING, &c.

POINT, in the manufactories, is a general term, used for all kinds of laces wrought with the needle; such are the point le Venice, point de France, point de Genoa, &c. which are distinguished by the particular economy and arrangement of their points.—*Point* is sometimes used for lace woven with bobbins; as English point, point de Malines, point d'Havre, &c.

POINT, in poetry, denotes a lively brisk turn or conceit, usually found or expected at the close of an epigram. See POETRY, n° 169.

Point-Blank, in gunnery, denotes the shot of a gun levelled horizontally, without either mounting or sinking the muzzle of the piece.—In shooting point-blank,

Vol. XV. Part I.

the shot or bullet is supposed to go directly forward in a straight line to the mark; and not to move in a curve, as bombs and highly elevated random-shots do.—When a piece stands upon a level plane, and is laid level, the distance between the piece and the point where the shot touches the ground first, is called the *point-blank* range of that piece; but as the same piece ranges more or less, according to a greater or less charge, the point-blank range is taken from that of a piece loaded with such a charge as is used commonly in action. It is therefore necessary that these ranges of all pieces should be known; since the gunner judges from thence what elevation he is to give to his pieces when he is either farther from or nearer to the object to be fired at; and this he can do pretty nearly by sight, after considerable practice.

POINTING, in grammar, the art of dividing a discourse, by points, into periods and members of periods, in order to show the proper pauses to be made in reading, and to facilitate the pronunciation and understanding thereof. See the article PUNCTUATION.

POINTS, in heraldry, are the several different parts of an escutcheon, denoting the local positions of any figure. See HERALDRY, p. 441. col. 2.

POINTS, in electricity, are those acute terminations of bodies which facilitate the passage of the electrical fluid from or to such bodies. See ELECTRICITY.

POINTS, or *Vowel Points*, in the Hebrew language. See PHILOLOGY, Sect. I. n° 31, &c.

POISON, is any substance which proves destructive to the life of animals in a small quantity, either taken by the mouth, mixed with the blood, or applied to the nerves. See MEDICINE, n° 261, 269, 303, 322, 408, &c. &c.

Of poisons there are many different kinds, which are exceedingly various in their operations. The mineral poisons, as arsenic and corrosive mercury, seem to attack the solid parts of the stomach, and to produce death by eroding its substance: the antimonials seem rather to attack the nerves, and to kill by throwing the whole system into convulsions; and in this manner also most of the vegetable poisons seem to operate. All of these, however, seem to be inferior in strength to the poisons of some of the more deadly kinds of serpents, which operate so suddenly that the animal bit by them will be dead before another that had swallowed arsenic would be affected.

Much has been written concerning a poison made use of by the African negroes, by the Americans, and by the East Indians. To this very strange effects have been ascribed. It has been said that by this poison a man might be killed at any certain time; as, for instance, after the interval of a day, a week, a month, a year, or even several years. These wonderful effects, however, do not seem worthy of credit; as the Abbé Fontana has given a particular account of an American poison called *ticunas*, which in all probability is the same with that used in Africa and the East Indies; and from his account it is extremely improbable that any such effects could be produced with certainty.

With this poison the Abbé was furnished by Dr Herberden. It was closed and sealed up in an earthen pot inclosed in a tin-case. Within the tin-case was a note containing the following words: "Indian poison, brought from the banks of the river of the Amazons

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Poison.

Poison.

by Don Pedro Maldonado. It is one of the forts mentioned in the Philosophical Transactions, Vol. XLVII. No 12." In the volume of the Philosophical Transactions here quoted, mention is made of two poisons little different in their activity; the one called the *poison of Lamas*, and the other of *Ticunas*. The poison in the earthen vessel used by the Abbé Fontana was that of the ticunas; he was also furnished with a number of American arrows dipped in poison, but whether that of the lamas or ticunas he could not tell.

Our author begins his account of the nature of this poison with detecting some of the mistakes which had been propagated concerning it.—It had been asserted, that the Ticunas poison proves noxious by the mere effluvia, but much more by the steam which exhales from it in boiling or burning: that, among the Indians, it is prepared only by women condemned to die; and that the mark of its being sufficiently prepared is when the attendant is killed by its steam. All these assertions are by the Abbé refuted in the clearest manner. He exposed a young pigeon to the smell of the poison when the vessel was opened, to the steam of it when boiling, and to the vapour of it when burning to the sides of the vessel, without the animal's being the least injured; on which, concluding that the vapours of this poison were not to be dreaded, he exposed himself to them without any fear.

This poison dissolves very readily even in cold water, and likewise in the vegetable and mineral acids. With oil of vitriol it becomes as black as ink, but not with the rest of the acids. In oil of vitriol it also dissolves more slowly than in any of the rest. It does not effervesce with acids or alkalis; neither does it alter milk, nor tinge it, except with the natural colour of the poison; nor does it tinge the vegetable juices either red or green. When examined by the microscope, there is no appearance of regularity or crystallization; but it for the most part appears made up of very small, irregular, roundish bodies, like vegetable juices. It dries without making any noise, and has an extremely bitter taste when put upon the tongue.

The ticunas poison is harmless when put into the eyes; nor is it fatal when taken by the mouth, unless the quantity is considerable. Six grains of the solid poison, dissolved in water, killed a young pigeon which drank it in less than 20 minutes. Five grains killed a small Guinea-pig in 25 minutes. Eight grains killed a

rabbit in an hour and eight minutes, &c. In those experiments it was observed that much less poison was required to kill an animal whose stomach was empty than one that had a full stomach. Three rabbits and two pigeons were killed in less than 35 minutes by taking a dose of three grains each on an empty stomach; but when the experiment was repeated on five animals with full stomachs, only one of them died.

The most fatal operation of this poison is when mixed with the blood. The smallest quantity, injected into the jugular vein, killed the animal as if by a stroke of lightning. When applied to wounds in such a manner that the flowing of the blood could not wash it away, the animal fell into convulsions and a train of fatal nervous symptoms, which put an end to its life in a few minutes. Yet, notwithstanding these seeming affections of the nerves, the poison proved harmless when applied to the naked nerves themselves, or even to the medullary substance of them slit open.

The strength of this poison seems to be diminished, and even destroyed, by mineral acids, but not at all by alkalis or ardent spirits; but if the fresh poison was applied to a wound, the application of mineral acids immediately after could not remove the pernicious effects. So far, indeed, was this from being the case, that the application of nitrous acid to the wounded muscle of a pigeon killed the animal in a short time without any poison at all.—The effects of the arrows were equally fatal with those of the poison itself (A).

The poison of the viper is analogous in its effects to that of ticunas, but inferior in strength; the latter killing more instantaneously when injected into a vein than even the poison of the most venomous rattlesnake.

The Abbé has, however, observed a difference in the action of the two poisons upon blood taken out of the body. He cut off the head of a pigeon, and received its blood into two warm conical glasses, to the amount of about 80 drops into each. Into the blood contained in one porringer, he put four drops of water; and into the other four drops of the poison dissolved in water as usual. The event of this experiment was, that the blood, with which the water only was mixed, coagulated in a short time; but that in which the poison was mixed did not coagulate at all. The poison of the viper also hinders the blood from coagulating, but gives it a much blacker tinge than the poison of the ticunas. The poison of the viper also proves certainly fatal when injected

(A) Mr Paterfon, in his travels in Africa, in the years 1777-8-9, fell in with an European woman who had been wounded with a poisoned arrow. Great pains had been taken to cure her, but in vain; for at different periods of the year an inflammation came on which was succeeded by a partial mortification. She told him that the wound was easily healed up; but in two months afterwards there was a certainty of its breaking out again, and this had been the case for many years. The Hottentots poison their arrows with a species of euphorbia. See EUPHORBIA.—The *amaryllis disticha*, a large bulbous plant growing about the Cape of Good Hope, called *mad poison*, is used for the same purpose. The natives take the bulbs when they are putting out their leaves, cut them transversely, extract a thick fluid, and keep it in the sun till it acquires the consistence of gum, when it is fit for use. With arrows poisoned with this gum they kill antelopes and other small animals intended for food. After they are wounded, the animals generally run for several miles, and are frequently not found till next day. When the leaves of this plant are young, the cattle are very fond of them, though they occasion instant death. Mr Paterfon mentions another shrubby plant producing a nut, called by the Dutch *woolf gift* or *wolf poison*, the only poison useful to the European inhabitants. The nuts are roasted like coffee, pulverized, and stuffed into some pieces of meat or a dead dog, which are thrown into the fields. By this means the voracious hyenas are generally killed. See RHUS.

Poison. injected into the veins, even in very small quantity; but it produces a kind of grumous coagulation and blackness in the blood when drawn from a vein, though it prevents the proper coagulation of that fluid, and its separation into crassamentum and serum as usual. See VIPER.

In the Philosophical Transactions, N^o 335. we have a number of experiments which show the effects of many different poisons upon animals; from whence it appears, that many substances which are not at all accounted poisonous, yet prove as certainly fatal when mixed with the blood as even the poison of rattlesnakes, or the ticunas itself.—An ounce of emetic wine, being injected into the jugular vein of a large dog, produced no effect for a quarter of an hour. At the expiration of that space he became sick, had a continual vomiting, and evacuation of some hard excrements by stool. By these evacuations he seemed to be somewhat relieved; but soon grew uneasy, moved from place to place, and vomited again. After this he laid himself down on the ground pretty quietly; but his rest was disturbed by a return of his vomiting, and his strength greatly decreased. An hour and an half after the operation he appeared half dead, but was greatly revived by having some warm broth poured down his throat with a funnel. This, however, proved only a temporary relief; for in a short time the vomiting returned, he made urine in great quantity, howled miserably, and died in convulsions.—A dram and an half of sal ammoniac dissolved in an ounce and an half of water, and injected into the jugular vein of a dog, killed him with convulsions almost instantly.—The same effect followed from injecting a dram of salt of tartar dissolved in an ounce of warm water; but a dram and an half of common salt injected into the jugular produced little other bad consequence than a temporary thirst.—A dram of purified white vitriol, injected into the crural vein of a dog, killed him immediately.—Fifteen grains of salt of urine dissolved in an ounce of water, and injected into the crural vein of a dog, threw him into such violent convulsions that he seemed to be dying; nevertheless he recovered from a second dose, though not without a great deal of difficulty: but an ounce of urine made by a man fasting produced no bad effect. Diluted aquafortis injected into the jugular and crural vein of a dog killed him immediately by coagulating the blood. Oil of sulphur (containing some quantity of the volatile vitriolic acid) did not kill a dog after repeated trials. On the contrary, as soon as he was let go, he ran into all the corners of the room searching for meat: and having found some bones, he fell a gnawing them with strange avidity, as if the acid, by injection into his veins, had given him a better appetite.—Another dog who had oil of tartar injected into his veins, swelled and died, after suffering great torment. His blood was found florid, and not coagulated.—A dram and a half of spirit of salt diluted with water, and injected into the jugular vein of a dog, killed him immediately. In the right ventricle of the heart the blood was found partly grumous and concreted into harder clots than ordinary, and partly frothy. Warm vinegar was injected without doing any manifest harm.—Two drams of sugar dissolved into an ounce of water were injected into the jugular vein of a dog without any hurt.

These are the results of the experiments where saline

substances were injected into the veins. Many acrids proved equally fatal. A decoction of two drams of white hellebore, injected into the jugular vein of a dog, killed him like a stroke of lightning. Another dog was killed in a moment by an injection of an ounce of rectified spirit of wine in which a dram of camphor was dissolved.—Ten drams of highly rectified spirit of wine, injected into the crural vein of a dog, killed him in a very short time: he died quietly, and licking his jaws with his tongue, as if with pleasure. In the vena cava and right ventricle of the heart the blood was coagulated into a great many little clots.—Three drams of rectified spirit of wine injected into the crural vein of a small dog made him apoplectic, and as it were half dead. In a little time he recovered from the apoplexy, and became giddy; and, when he endeavoured to go, reeled and fell down. Though his strength increased by degrees, yet his drunkenness continued. His eyes were red and fiery; and his sight so dull that he scarce seemed to take notice of any thing: and when he was beat, he would scarce move. However, in four hours he began to recover, and would eat bread when offered him; the next day he was out of danger.—Five ounces of strong white-wine injected into the crural vein of a dog made him very drunk for a few hours, but did not produce any other consequences. An ounce of strong decoction of tobacco injected into a vein killed a dog in a very short time in terrible convulsions. Ten drops of oil of sage rubbed with half a dram of sugar, and thus dissolved in water, did no harm by being injected into the blood.

Mercury, though seemingly void of all acrimony, proves also fatal when injected into the blood. Soon after the injection of half an ounce of this mineral into the jugular vein of a dog, he was seized with a dry short cough which came by intervals. About two days after, he was troubled with a great difficulty of breathing, and made a noise like that of a broken-winded horse. There was no tumour about the root of the tongue or the parotid glands, nor any appearance of a salivation. In four days he died; having been for two days before so much troubled with an orthopnea, that he could sleep only when he leaned his head against something. When opened, about a pint of bloody serum was found in the thorax, and the outside of the lungs in most places was blistered. Some of the blisters were larger and others smaller than a pea, but most of them contained mercurial globules. Several of them were broken; and upon being pressed a little, the mercury ran out with a mixture of a little sanies; but upon stronger pressure, a considerable quantity of sanies issued out. In the right ventricle of the heart some particles of quicksilver were found in the very middle of the coagulated blood lodged there, and the same thing also was observed in the pulmonary artery. Some blood also was found coagulated in a very strange and unusual manner between the columnæ of the right ventricle of the heart, and in this a greater quantity of quicksilver than anywhere else. In the left ventricle was found a very tenacious blood, coagulated, and sticking to the great valve, including the tendons of it, and a little resembling a polypus. No mercury could be found in this ventricle by the most diligent search; whence it appears, that the mercury had passed no farther than the extremities of the pulmonary artery, where it had stuck, and occasioned fatal obstructions.—In another dog, which had mercury injected

Poison.

into the jugular, it appears to have passed the pulmonary artery, as part of it was found in the cavity of the abdomen, and part also in some other cavities of the body. All the glands were very turgid and full of liquor, especially in the ventricles of the brain, and all round there was a great quantity of serum.

In like manner, oil of olives proves certainly fatal when injected into the blood. Half an ounce of this, injected into the crural vein of a dog, produced no effect in half a quarter of an hour: but after that, the animal barked, cried, looked dejected, and fell into a deep apoplexy; so that his limbs were deprived of all sense and motion, and were flexible any way at pleasure. His respiration continued very strong, with a snorting and wheezing, and a thick humour sometimes mixed with blood flowing out of his mouth. He lost all external sense: the eyes, though they continued open, were not sensible of any objects that were put to them; and even the cornea could be touched and rubbed, without his being the least sensible of it: his eyelids, however, had a convulsive motion. The hearing was quite lost; and in a short time the feeling became so dull, that his claws and ears could be bored with red-hot pincers without his expressing the least sense of pain. Sometimes he was seized with a convulsive motion of the diaphragm and muscles subservient to respiration; upon which he would bark strongly, as if he had been awake: but this waking was only in appearance; for all the time of this barking he continued as insensible as ever. In three hours he died; and on opening his body, the bronchiæ were filled with a thick froth.—An ounce of oil of olives injected into the jugular of another dog killed him in a moment; but a third lived an hour after it. He was seized with great sleepiness, snorting, and wheezing, but did not bark like the first. In all of them a great quantity of thick froth was found in the lungs.

We come now to speak of those poisons which prove mortal (B) when taken by the mouth. The principal of these are, arsenic, corrosive mercury, glass of antimony, and lead*. What the effects of these substances are when injected into the blood, cannot be related, as no experiments seem to have been made with them in that way, excepting antimony, whose effects have been already mentioned. The effects of opium, when injected into the veins, seem to be similar to its effects when taken by the mouth. Fifty grains of opium, dissolved in an ounce of water, were injected into the crural vein of a cat. Immediately after the operation she seemed much dejected, but did not cry; only made a low, interrupted, and complaining noise. This was

succeeded by trembling of the limbs, convulsive motions of the eyes, ears, lips, and almost all parts of the body, with violent convulsions of the breast. Sometimes she would raise up her head, and seem to look about her; but her eyes were very dull, and looked dead. Though she was let loose, and had nothing tied about her neck, yet her mouth was so filled with froth, that she was almost strangled. At last, her convulsive motions continuing, and being seized with stretching of her limbs, she died in a quarter of an hour. Upon opening the body, the blood was found not to be much altered from its natural state.—A dram and an half of opium was dissolved in an ounce and an half of water, and then injected into the crural vein of a lusty strong dog. He struggled violently; made a loud noise, though his jaws were tied; had a great difficulty of breathing, and palpitation of the heart; with convulsive motions of almost all parts of his body. These symptoms were succeeded by a profound and apoplectic sleep. Having untied him, he lay upon the ground without moving or making any noise, though severely beaten. About half an hour after he began to recover some sense, and would move a little when beaten. The sleepiness still decreased; so that in an hour and a half he would make a noise and walk a little when beat. However, he died in four days, after having voided a quantity of fetid excrements, in colour resembling the diluted opium he had swallowed.

The oil of tobacco has generally been reckoned a very violent poison when introduced into the blood; but from the Abbé Fontana's experiments, it appears to be far inferior in strength to the poison of tiguas, or to the bite of a viper. A drop of oil of tobacco was put into a small incision in the right thigh of a pigeon, and in two minutes the animal could not stand on its right foot. The same experiment was repeated on another pigeon and produced exactly the same effect. In another case, the oil was applied to a slight wound in the breast; three minutes after which, the animal could not stand on the left foot. This experiment was also repeated a second time, with the same success. A tooth-pick, steeped in oil of tobacco, and introduced into the muscles of the breast, made the animal fall down in a few seconds as if dead. Applied to two others, they threw up several times all the food they had eaten. Two others treated in the same manner, but with empty stomachs, made many efforts to vomit.—In general, the vomiting was found to be a constant effect of this poison: but the loss of motion in the part to which the poison is applied, was found to be only accidental. None of the animals died by the application

Poison.

* See *Chemistry*, n^o 925, 1256, &c. *Medicine* as above referred to, and *Pharmacy*, *passim*.

* See *Leake's Practical Treatise on Diseases of the Viscera*.

(B) Of all poisons* those which may be called culinary are perhaps the most destructive, because they are generally the least suspected. All copper † vessels, therefore, and vessels of bell-metal, which contains copper, † See *Poison of Copper* should be laid aside. Even the common *earthen-ware*, when they contain acids, as in pickling, become very pernicious, as they are glazed with lead, which in the smallest quantity when dissolved is very fatal; and even tin, the least exceptionable of the metals for culinary purposes except iron, is not always quite free of poisonous qualities, it having been found to contain a small portion of arsenic. Mushrooms and the common laurel are also very fatal. The bitter almond contains a poison, and its antidote likewise. The cordial dram *ratafia*, much used in France, is a slow poison, its flavour being procured from the kernels of peach, black cherry stones, &c.—The spirit of *lauro-cerasus* is peculiarly fatal. The adulteration of bread, beer, wine, porter, &c. produces very fatal consequences, and merits exemplary punishment. Next to culinary poisons the abuse of medicines deserves particular attention.

Poison.

application of oil of tobacco. Dr Leake however asserts the contrary; saying, that this oil, which is used by the Indians in poisoning arrows, when infused into a fresh wound, besides sickness and vomiting, occasions convulsions and death. See *Practical Essay on Diseases of the Viscera*, p. 67.

The pernicious effects of laurel-water are taken notice of under the article MEDICINE, n° 261. The account is confirmed by the experiments of the Abbé Fontana; who tells us, that it not only kills in a short time when taken by the mouth, but that, when given in small doses, the animal writhes so that the head joins the tail, and the vertebræ arch out in such a manner as to strike with horror every one who sees it. In order to ascertain the effects of this water when taken into the blood, our author opened the skin of the lower belly of a pretty large rabbit, and made a wound in it about an inch long; and having slightly wounded the muscles under it in many parts, applied two or three tea-spoonfuls of laurel-water. The animal fell down convulsed in less than three minutes, and died soon after. The experiment was repeated with similar success in other animals; but was always found to act most powerfully, and in the shortest time, when taken by the mouth, or injected by way of clyster. From these experiments, however, he concluded, that laurel-water would kill by being injected into the blood: but in this he was deceived; for two rabbits had each of them a large tea-spoonful injected into the jugular vein, without any inconvenience either at the time of injection or afterwards. It proved innocent also when applied to the bare nerves, and even when introduced into their medullary substance.

We ought now to give some account of the proper antidotes for each kind of poison; but from what has been related concerning the extreme activity of some of them, it is evident that in many cases there can be but very little hope. People are most apt to be bit by serpents in the legs or hands; and as the poison, from the Abbé Fontana's experiments, appears to act only in consequence of being absorbed into the blood, it is plain, that to prevent this absorption is the chief indication of cure. We have recommended several methods for this purpose under the article MEDICINE, n° 408.; but the Abbé Fontana proposes another not mentioned there, namely, ligature. This, if properly applied between the wounded part and the heart, must certainly prevent the bad effects of the poison: but then it tends to produce a disease almost equally fatal; namely, a gangrene of the part; and our author gives instances of animals being thus destroyed after the effects of the poison were prevented; for which reason he prefers amputation. But the good effects of either of these methods, it is evident, must depend greatly on the nature of the part wounded, and the time when the ligature is applied or the amputation performed. If the teeth of the serpent, or the poisoned arrow, happens to strike a large vein, the only possibility of escaping instant death is to compress the trunk of the vein above the wounded place, and to enlarge the wound, that the blood may flow freely and in large quantity, in order to wash away the poison, and discharge the infected parts of the blood itself. If this is neglected, and the person falls into the agonies of death, perhaps strongly stimulating medicines given in large doses, and continued for a

length of time, may enable nature to counteract the virulence of the poison. For this purpose volatile alkalis seem most proper, as acting soonest. See MEDICINE, p. 346. col. 2. and p. 347. col. 1.; and perhaps a combination of them with ether might be advantageous, as by the volatility of that medicine the activity of the alkali would probably be increased. In the Philosophical Transactions, we have an account of the recovery of a dog seemingly by means of the volatile alkali, when probably he was in a dying condition. This dog indeed seems to have had a remarkable strength of constitution. The poor creature had first got two ounces of the juice of nightshade, which he bore without any inconvenience. An equal quantity of the juice of hemlock was then given him without effect. He then got a large dose of the root of wolfsbane with the same success. Two drachms of white hellebore root were next given. These caused violent vomitings and purgings, but still he outlived the operation. He was then made to swallow five roots of the colchicum, or meadow-saffron, dug fresh out of the earth. The effect of these was similar to that of the white hellebore, but still he did not die. Lastly, he got two drams of opium; and he even outlived this dose. He was first cast into a deep sleep by it; but soon awaked, and was seized with violent vomitings and purgings, which carried off the effect of the opium. Seeing then that the animal had resisted the most violent poisons, it was resolved to try the effects of the bite of a viper; and he was accordingly bit three or four times on the belly a little below the navel by one enraged. The immediate consequence of this was an incipient gangrene in the parts adjoining to the wound, as appeared by the rising of little black bladders filled with a sanious matter, and a livid colour which propagated itself all around. The motion of the heart became very faint and irregular, and the animal lay without strength or sensation, as if he had been seized with a lethargy or apoplexy. In this condition his wound was cupped and scarified, and Venice treacle (a famous antidote) applied to it. In two hours after this all the symptoms were increased, and he seemed to be nearly dead; upon which half a drachm of volatile salt of hartshorn mixed with a little broth was poured down his throat; and the consequence was, that in a short time he was able to stand on his feet and walk. Another dose entirely dispelled his lethargy, and the heart began to recover its strength. However, he continued very weak; and though he eat no solid meat for three days, yet at the end of that time his strength was evidently increased. The first day he drank water plentifully and greedily, and on the second day he drank some broth. On the third day he began to eat solid meat, and seemed out of danger; only some large and foul ulcers remained on that part of the belly which was bit, and before these were healed he was killed by another dog.

From comparing this with some other observations, indeed, it would seem that volatile alkali is the best antidote against all poisons which suddenly kill by a mixture with the blood, and even of some others. Indeed its effects in curing the bite of snakes seems to be put beyond all doubt, by a paper in the 2d volume of the Asiatic Researches, p. 323. "From the effect of a ligature applied between the bitten part and the heart (says Mr Williams, the author of the paper), it is evident that

Poison.

Poison.

that the poison diffuses itself over the body by the returning venous blood; destroying the irritability, and rendering the system paralytic. It is therefore probable, that the volatile caustic alkali, in resisting the disease of the poison, does not act so much as a specific in destroying its quality, as by counteracting the effect on the system, by stimulating the fibres, and preserving that irritability which it tends to destroy."

But whatever be the mode of its operation, the medicine is unquestionably powerful. Mr Williams used either the volatile caustic alkali, or eau-de-luce; the former of which he seems to have preferred. Of it he gave 60 drops as a dose in water, and of the eau-de-luce he gave 40, at the same time applying some of the medicine to the part bitten, and repeating the dose as he found occasion. Of seven cases, some of which were apparently very desperate, only one died, and that appears to have been occasioned by bad treatment after the cure. Many of the patients were perfectly recovered in seven or eight minutes, and none of them required more than two hours: On the whole, Mr Williams says that he "never knew an instance of the volatile caustic alkali failing in its effect, where the patient has been able to swallow it." Dr Mead asserts, that the alkali counteracts the deadly effects of laurel water; we have seen its effects in curing the bite of a viper, and of snakes; and from Dr Wolfe's experiments on hydrophobous patients, it may even claim some merit there. Still, however, there is another method of attempting a cure in such deplorable cases; and that is, by injecting into the veins any thing which will not destroy life, but will destroy the effects of the poison. It is much to be regretted, that in those cruel experiments which we have already related, the intention seems almost always to have been to kill the animal at all events; whereas, it ought to have been to preserve him alive, and to ascertain what medicines could be safely injected into the blood, and what could not, with the effects which followed the injection of different quantities, none of which were sufficient to destroy life. But in the way they were managed, scarce any conclusion can be drawn from them. Indeed it appears that little good is to be expected from this mode; it is mere speculation, and future experiments must show whether it ever shall be used for the cure of poisons, or for any other purposes; its being now totally laid aside, seems to militate strongly against the efficacy of it; besides, the extreme cruelty of the operation will ever be a strong bar to its general introduction. See INJECTION.

There still remains another method of cure in desperate cases, when there is a certainty, that the whole mass of blood is infected; and that is, by the bold attempt of changing the whole diseased fluid for the blood of a sound animal. Experiments of this kind have also been tried; and the method of making them, together with the consequences of such as are recorded in the Philosophical Transactions, we shall notice under the article TRANSFUSION.

Dr Mead, finding that many pretenders to philosophy have called the goodness of the Creator in question, for having created substances whose manifest and obvious qualities are noxious and destructive, remarks, by way of answer, that they have also salutary virtues. But, besides their physical effects, they are likewise food for animals which afford us good nourishment, goats and

quails being fattened by hellebore, starlings by hemlock, and hogs innocently eating henbane; besides, some of those vegetables, which were formerly thought poisonous, are now used in medicine, and future discoveries may probably increase the number. The poison of many vegetables is their only defence against the ravages of animals; and by means of them we are often enabled to defend useful plants from the destroying insect; such as by sprinkling them with essential oil of turpentine; and by means of some substances poisonous to them, we are enabled to destroy those insects which infest the human body, and the bodies of domestic animals, &c.—As for poisonous minerals, arsenic for example, Dr Mead observes, that it is not a perfect mineral, but only an active substance, made use of by nature in preparing several metals in the earth, which are of great service to mankind; and, after confirming this by several instances, he concludes by saying, the case will be found much the same in all natural productions of this kind. As for poisonous animals, &c. their noxious qualities may easily be accounted for, by reflecting that it is their only mode of self-defence. See ARANEA, p. 195. and SERPENT.

Poison of Copper. This metal, though when in an undissolved state it produces no sensible effects, becomes exceedingly active when dissolved; and such is the facility with which the solution is effected, that it becomes a matter of some consequence to prevent the metal from being taken into the human body even in its proper form. It doth not, however, appear that the poison of copper is equally pernicious with those of arsenic or lead; much less with some others treated of in the last article. The reason of this is, that it excites vomiting so speedily as to be expelled, even though taken in considerable quantity, before it has time to corrode the stomach. Roman vitriol, which is a solution of copper in the vitriolic acid, has been used as a medicine in some diseases with great success. Verdigrise also, which is another very active preparation of the metal, has been by some physicians prescribed as an emetic, especially in cases where other poisons had been swallowed, in order to procure the most speedy evacuation of them by vomit. Where copper is not used with this view, it has been employed as a tonic and antispasmodic, with which it has been admitted into the Edinburgh Dispensatory under the title of *Cuprum Ammoniacale*. The effects of the metal, however, when taken in a pretty large quantity, and in a dissolved state, or when the stomach abounds with acid juices sufficient to dissolve it, are very disagreeable and even dangerous; as it occasions violent vomitings, pains in the stomach, faintings, and sometimes convulsions and death. The only cure for these symptoms is to expel the poison by vomiting as soon as possible, and to obtund its acrimony; for which purpose drinking warm milk will probably be found the most efficacious remedy. In order to prevent the entrance of the poison into the body, no copper vessels should be used in preparing food but such as are either well tinned or kept exceedingly clean. The practice of giving a fine blue or green colour to pickles, by preparing them in copper vessels, ought not to be tolerated; for Dr Falconer, in a treatise on this subject, assures us, that these are sometimes so strongly impregnated by this method of preparing

Poison.

Poison.

Poison.

preparing them, that a small quantity of them will produce a slight nausea.—Mortars of brass or bell-metal ought for the same reason to be avoided, as by this means a considerable quantity of the pernicious metal may be mixed with our food, or with medicines. In other cases, an equal caution ought to be used. The custom of keeping pins in the mouth, of giving copper halfpence to children to play with, &c. ought to be avoided; as thus a quantity of the metal may be insensibly taken into the body, after which its effects must be uncertain.—It is proper to observe, however, that copper is much more easily dissolved when cold than when hot; and therefore the greatest care should be taken never to let any thing designed for food, even common water, remain long in copper vessels when cold; for it is observed, that though the confectioners can safely prepare the most acid syrups in clean copper vessels without their receiving any detriment whilst hot, yet if the same syrups are allowed to remain in the vessels till quite cold, they become impregnated with the pernicious qualities of the metal.

POISON of Lead. See MEDICINE, n° 303.

POISON-Tree. See RHUS.

POISON-Tree of Java, called in the Malayan language *bobun upas*, is a tree which has often been described by naturalists; but its existence has been very generally doubted, and the descriptions given of it containing much of the marvellous, have been often treated as idle fictions. N. P. Foersch, however, in an account of it written in Dutch, asserts that it does exist; and tells us, that he once doubted it as much as any person; but, determined not to trust general opinions, he made the most particular inquiries possible; the result of which was, that he found that it is situated in the island of Java, about 27 leagues from Batavia, 14 from Soura Charta, the emperor's seat, and about 19 from Tinkjoe, the residence of the sultan of Java. It is surrounded on all sides by hills and mountains, and the adjacent country for 12 miles round the tree is totally barren. Our author says he has gone all round the spot at about 18 miles from the centre, and on all sides he found the country equally dreary, which he ascribes to its noxious effluvia. The poison procured from it is a gum, issuing from between the bark and the tree; and it is brought by malefactors who have been condemned to death, but who are allowed by this alternative to have a chance for their life. An old ecclesiastic, our author informs us, dwelt on the outside of the surrounding hills, whose business it was to prepare the criminals for their fate, if death should be the consequence of their expedition. And indeed so fatal is its effluvia, that he acknowledged that scarcely two out of 20 returned from above 700 whom he had dismissed.

Mr Foersch farther tells us, that he had seen several of the criminals who had returned, and who told him, that the tree stands on the borders of a rivulet, is of a middling size, and that five or six young ones of the same kind stand close to it. They could not, however, see any other plant or shrub near it; and the ground was of brownish sand, full of stones and dead bodies, and difficult to pass. The Malaysians think this tract was thus rendered noxious and uninhabitable by the judgment of God, at Mahomet's desire, on account of the sins of the inhabitants. No animal whatever is ever

seen there; and such as get there by any means never return, but have been brought out dead by such of the criminals as have themselves escaped death.

Our author relates a circumstance which happened in the year 1775, to about 400 families (1600 souls), who refused to pay some duty to the emperor, and who were in consequence declared rebels and banished: they petitioned for leave to settle in the uncultivated parts round Upas: the consequence of which was, that in less than two months their number was reduced to about 300 souls, who begged to be reconciled to the emperor, and were again received under his protection. Many of these survivors Mr Foersch saw, and they had just the appearance of persons tainted with an infectious disorder.

With the juice of this tree arrows, lancets, and other offensive weapons, are poisoned. With lancets thus poisoned, Mr Foersch observes, that he saw 13 of the emperor's concubines executed for infidelity to his bed in February 1776. They were lanced in the middle of their breasts; in five minutes after which they were seized with a *tremor* and *subultus tendinum*, and in 15 minutes they were dead. Their bodies were full of livid spots, like those of *petechia*, their faces swelled, colour blue, and eyes yellow, &c. Soon after he saw seven Malaysians executed in the same way, and saw the same effects follow; on which he resolved to try it on other animals, and found the operation similar on three puppies, a cat, and a fowl, none of which survived more than 13 minutes. He also tried its effects internally on a dog seven months old; the animal became delirious, was seized with convulsions, and died in half an hour. From all which our author concludes, that it is the most violent of all vegetable poisons, and that it contributes greatly to the unhealthiness of the island in which it grows. By means of it many cruel and treacherous murders are perpetrated. He adds, that there exists a sort of cajoe-upas on the coast of Macassar, the poison of which, though not near so violent or malignant, operates nearly in the same manner.

To this account our readers will give such a degree of credit as they think is due; it is our business however to add, that it has been controverted in all its parts in a memoir of Lambert Nolst, M. D. fellow of the Batavian Experimental Society at Rotterdam, (see Gentleman's Mag. May 1794, p. 433.) This memoir was procured from John Matthew a Rhyn, who had been 23 years, from 1763 to 1786, resident in the island, and therefore had every opportunity of informing himself on the spot. In this memoir we are told, that Foersch's account of the tree is extremely suspicious, from a variety of circumstances: 1. Though he had letters of introduction, he went to no considerable house, and afterwards privately withdrew among the English. 2. When the emperor was asked respecting Foersch, and the facts he relates, he answered, that he had never heard either of him or of the tree. 3. The distances given to mark the situation of the tree are not accurate. 4. The execution of criminals is different from what he represents. 5. The circumstance of several criminals returning when Foersch was there has a suspicious appearance. 6. There exists no such tradition, as that the tree was placed there by Mahomet. 7. There were no such disturbances in 1775 as Foersch represents, the tract to which

Pola
Poland.

which he alludes having submitted to the Dutch East India Company as early as 1756. 8. The island is not unhealthy, as Foersch asserts; nor are violent or premature deaths frequent. 9. The Javanese are a curious and intelligent people, and of course could not be so ignorant of this tree if it had any existence. 10. The assertions and pretended facts of Foersch have no collateral evidence; and every thing which we gather from the accounts of others, or from the history of the people, invalidates them. For these and other reasons, Dr Nolst concludes, that very little credit is due to the representations of Foersch, and that the island of Java produces no such tree, which, if it really grew there, would be the most remarkable of all trees.

POLA, in ichthyology, is the name of a flat fish, resembling the foal, but somewhat shorter and smaller. It is called *cynoglossus* and *linguacula*. It abounds in the Mediterranean, and is sold both in Rome and in Venice for the table.

POLACRE, a ship with three masts, usually navigated in the Levant and other parts of the Mediterranean. These vessels are generally furnished with square sails upon the main-mast, and lateen sails upon the fore-mast and mizen-mast. Some of them, however, carry square sails upon all the three masts, particularly those of Provence in France. Each of their masts is commonly formed of one piece, so that they have neither top-mast nor top-gallant-mast; neither have they any *borjes* to their yards, because the men stand upon the top-sail-yard to loose or furl the top-gallant-sail, and on the lower-yard to reef, to loose, or furl, the top-sail, whose yard is lowered sufficiently down for that purpose.

POLAEDRASTYLA, in natural history, is the name of a genus of crystals, derived from the Greek *πολυς*, many, *ἰδρα*, sides, the primitive particle *α*, not, and *στυλος*, a column; and means a crystal with many planes, and without a column.

The bodies of this genus are crystals of two octangular pyramids, with the bases joined, the whole body consisting of 16 planes. Of this genus there are only two species known: 1. A brown kind with short pyramids, found in great plenty in Virginia on the sides of hills; and, 2. A colourless one, with longer pyramids. This has yet been found only in one place, which is the great mine at Gossalaer, in Saxony, where it usually lies at great depths.

POLAND, a kingdom of Europe, in its largest extent bounded by Pomerania, Brandenburg, Silesia, and Moravia, to the west; and, towards the east, by part of Russia and the Lesser Tartary; on the north, it has the Baltic, Russia, the grand province of Livonia, and Samogitia; and on the south, it is bounded by Bessarabia, Transylvania, Moldavia, and Hungary. Geographers generally divide it into the provinces of Poland Proper, Lithuania, Samogitia, Courland, Prussia, Massovia, Polachia, Polesia, Little Russia, called likewise *Russia Rubra* or *Red Russia*, Podolia, and the Ukrain. Now, however, it is very considerably reduced in extent, as will appear in the course of its history. For a map of Poland, Lithuania, and Prussia, see Plate CCCCX.

With regard to the history of Poland, we are not to gather the earlier part of it from any accounts transmitted to us by the natives. The early histories of all

nations indeed are involved in fable; but the Poles never had even a fabulous history of their own nation. The reason of this is, that it was not the custom with that nation to entertain itinerant poets for the amusement of the great; for to the songs of these poets entertained among other nations we are obliged for the early part of their history; but this assistance being deficient in Poland, we must have recourse to what is recorded concerning it by the historians of other nations.

The sovereigns of Poland at first had the title of *Polish sovereigns*, as if their office had been only to lead the armies into the field. The first of these is universally allowed to have been Lechus or Lecht; and to render him more illustrious, he is said to have been a lineal descendant from Japhet the son of Noah. According to some writers, he migrated at the head of a numerous body of the descendants of the ancient Scavi from some of the neighbouring nations; and, to this day, Poland is called by the Tartars the kingdom of *Lechus*. Buching, however, gives a different account of the origin of the Poles. Sarmatia, he observes, was an extensive country, inhabited by a variety of nations of different names. He supposes the Poles to be the descendants of the ancient Lazi, a people who lived in Colchis near the Pontus Euxinus; whence the Poles are sometimes called *Polazi*. Crossing several rivers, they entered Posnania, and settled on the borders of the Warta, while their neighbours the Zechi settled on the Elbe, in the 550th year of Christ. As to the name of *Poland*, or *Polka*, as it is called by the natives, it comes from the Slavonic word *Pole*, or *Poln*, which signifies a country adapted to hunting, because the whole country was formerly covered with vast forests, exceedingly proper for that employment.

Of the transactions of Lechus during the time that he enjoyed the sovereignty, we have no certain account. His successor was named *Viscimer*, who is generally supposed to have been the nephew of Lechus. He was a warlike and successful prince, subduing many provinces of Denmark, and building the city of Wismar, so called from the name of the sovereign. But the Danish historians take no notice of his wars with their country; nor do they even mention a prince of this name. However, he is said to have reigned for a long time with great glory; but to have left the people in great distress, on account of the disputes which arose about a successor.

After the death of *Viscimer*, the nobility were on the point of electing a sovereign, when the people, harassed by the grievous burdens occasioned by the wars of *Viscimer*, unanimously demanded another form of government, that they might no longer be liable to suffer from ambition and tyranny. At first the nobility pretended to yield to this humour of the people with great reluctance; however, they afterwards determined on such a form of government as threw all the power into their own hands. Twelve palatines, or vaivodes, were chosen; and the Polish dominions divided into as many provinces. These palatines exercised a despotic authority within their several jurisdictions, and aggravated the misery of the people by perpetual wars among themselves; upon which the Poles, worn out with oppression, resolved to return to their old form of government. Many assemblies were held for

Poland.

1
Polish so-
vereigns at
first only
styled
dukes.
2
Lechus the
first duke.

3
Derivation
of the diffe-
rent names
of Poland.

4
Viscimer
the second
duke.

5
Form of
govern-
ment chan-
ged into
aristocracy.



Polands

for this purpose; but, by reason of the opposition of the vaivodes, they came to nothing. At last, however, they cast their eyes upon Cracus, or Gracus, whose wealth and popularity had raised him to the highest honours among his countrymen. The Poles say that he was a native of Poland, and one of the 12 vaivodes; but the Bohemians affirm that he was a native of their country: however, both agree in maintaining, that he was descended from the ancient family of the Gracchi in Rome; who, they say, were banished to this country. He is said to have signalized himself against the Franks, whom he overthrew in some desperate engagements, and afterwards built the city of Cracow with their spoils. He did not enlarge his dominions, but made his subjects happy by many excellent regulations. At last, after a long and glorious reign, he expired, or, according to some, was assassinated by a nobleman who aspired to the crown.

6
The duke-
dom resto-
red.

Cracus left three children; Cracus, Lechus, and a daughter named *Vanda*. The first succeeded to the dukedom in virtue of his birthright; but was soon after murdered by his brother Lechus. However, it seems the thoughts of the crime which he had committed so disturbed his conscience, that the secret could not be kept. When it was known that he had been the murderer of his late sovereign, he was deposed with all possible marks of ignominy and contempt, and his sister *Vanda* declared duchess. She was a most beautiful and accomplished lady; and soon after she had been raised to the sovereignty, one *Rithogar*, a Teutonic prince, sent an ambassador demanding her in marriage, and threatening war if his proposals were refused. *Vanda* marched in person against him at the head of a numerous army, and the event proved fatal both to *Rithogar* and herself. The troops of *Rithogar* abandoned him without striking a blow, upon which he killed himself in despair; and *Vanda*, having become enamoured of him, was so much concerned for his death, that she drowned herself in the river *Vistula* or *Wesel*. From this unfortunate lady the country of *Vandalia* takes its name.

7
Again abo-
lished.

The family of Cracus having become extinct by the death of *Vanda*, the Poles were again left at liberty to choose a new sovereign or a new form of government. Through a natural levity, they changed the form of government, and restored the vaivodes notwithstanding all that they had formerly suffered from them. The consequences were the same as before: the vaivodes abused their power; the people were oppressed, and the state was distracted between foreign wars and civil contentions. At that time the Hungarians and Moravians had invaded Poland with a numerous army, and were opposed only by a handful of men almost ready to surrender at discretion. However, one *Premislaus*, a private soldier, contrived a stratagem by which the numerous forces of the enemy were overthrown; and for his valour was rewarded with the dukedom. We are ignorant of the other transactions of his reign; but all historians inform us that he died deeply regretted, and without issue; so that the Poles had once more to choose a sovereign.

8
Restored
a second
time.

On the death of *Premislaus* several candidates appeared for the throne; and the Poles determined to prefer him who could overcome all his competitors in a horse-race. A stone pillar was erected near the capital, on which

were laid all the ensigns of the ducal authority; and an herald proclaimed, that he who first arrived at that pillar from a river at some distance, named *Pouderic*, was to enjoy them. A Polish lord named *Lechus* was resolved to secure the victory to himself by a stratagem; for which purpose he caused iron spikes to be driven all over the course, reserving only a path for his own horse. The fraudulent design took effect in part, all the rest of the competitors being dismounted, and some severely hurt by their fall. *Lechus*, in consequence of this victory, was about to be proclaimed duke; when, unluckily for him, a peasant who had found out the artifice opposed the ceremony; and upon an examination of the fact, *Lechus* was torn in pieces, and the ducal authority conferred upon the peasant.

The name of the new monarch was also *Lechus*. He attained the sovereignty in the year 774, and behaved with great wisdom and moderation. Though he possessed the qualities of a great warrior, and extended his dominions on the side of Moravia and Bohemia, yet his chief delight was to make his subjects happy by peace. In the decline of life he was obliged to engage in a war with *Charlemagne*, and is said by some to have fallen in battle with that powerful monarch; though others assert that he died a natural death, having lived so long that the springs of life were quite worn out.

Lechus III. was succeeded by his son *Lechus IV.* who inherited all his father's virtues. He suppressed an insurrection in the Polish provinces, by which he acquired great reputation; after which he led his army against the Greek and Italian legions who had overrun *Pannonia*. He gained a complete victory over his enemies. Nor was his valour more conspicuous in the battle than his clemency to the vanquished: for he dismissed all his prisoners without ransom; demanding no other conditions than that they should never again disturb the peace of Poland, or the allies of that kingdom. This duke is said to have been endowed with many virtues, and is charged only with the vice of incontinence. He left 20 natural children, and only one legitimate son, named *Popiel*, to whom he left the sovereignty. *Popiel* was also a virtuous and pacific prince, who never had recourse to arms but through necessity. He removed the seat of government from Cracow to *Gnesna*, and was succeeded by his nephew *Popiel II.* a minor.

The young king behaved with propriety as long as he was under the tuition of others; but as soon as he had got the reins of government into his own hands the face of affairs was altered. *Lechus III.* who, as hath been already mentioned, had 20 illegitimate children, had promoted them to the government of different provinces; and they had discharged the duties of their offices in such a manner as showed that they were worthy of the confidence reposed in them. However, as soon as *Popiel* came of age, being seduced by the advice of his wife, an artful and ambitious woman, he removed them from their posts, treated them with the utmost contempt, and at last found means to poison them all at once at an entertainment. A dreadful punishment, however, according to the historians of those times, attended his treachery and cruelty. The bodies of the unhappy governors were left unburied; and from them issued a swarm of rats, who pursued *Popiel*, his wife, and children, wherever they went, and at last devoured them. The nation now became a prey to civil discord at the same time that it was

M m

harassed

Poland.

9
Why the
sovereigns
of Poland
are called
Piastes.

harassed by a foreign enemy; and, in short, the state seemed to be on the verge of dissolution, when Piastus was proclaimed duke in 830, from whom the natives of ducal or regal dignity were called *Piastes*. See *PIASTUS*. This excellent monarch died in 861, and was succeeded by his son Ziemovitus, who was of a more warlike disposition than his father, and who first introduced a regular discipline among the Polish troops. He maintained a respectable army, and took great pains to acquire a perfect knowledge in the art of war. The consequence of this was, that he was victorious in all his battles; and retook from the Germans and Hungarians not only all that they had gained, but enlarged his dominions beyond what they had been. After his death nothing remarkable happened in Poland till the time of Mieczslaus I. who attained the ducal authority in 964. He was born blind, and continued so for seven years: after which he recovered his sight without using any medicine; a circumstance so extraordinary, that in those times of ignorance and superstition it was accounted a miracle. In his reign the Christian religion was introduced into Poland. The most probable account of the manner in which Christianity was introduced is, that Mieczslaus having by ambassadors made his addresses to Daborwka daughter to the Duke of Bohemia, the lady rejected his offer unless he would suffer himself to be baptized. To this the duke consented, and was baptized, after having been instructed in the principles of Christianity. He founded the archbishoprics of Gnesna and Cracow; and appointed St Adalbert, sent by the pontiff to propagate Christianity in Poland, primate of the whole kingdom. On the birth of his son Boleslaus he redoubled his zeal; founding several bishoprics and monasteries; ordering likewise that, when any part of the Gospel was read, the hearers should half-draw their swords, in testimony of their readiness to defend the faith. He was, however, too superstitious to attend to the duties of a sovereign; and suffered his dominions to be ravaged by his barbarous neighbour the duke of Russia. Yet, with all his devotion, he could not obtain the title of king from the pope, though he had warmly solicited it; but it was afterwards conferred on his son, who succeeded to all his dominions.

10
Christiani-
ty intro-
duced by Mi-
eczslaus I.

Boleslaus I. the first king of Poland, surnamed *Chrobry*, succeeded to the sovereignty in 999. He also professed and cherished Christianity, and was a man of great valour and prudence. However, the first transaction of his reign favoured very much of the ridiculous piety of those times. He removed from Prague to Gnesna the remains of a saint which he had purchased at a considerable price. The Emperor Otho III. made a pilgrimage, on account of a vow, to the tomb of this saint. He was hospitably received by Boleslaus, whom, in return, he invested with the regal dignity; an act which was confirmed by the pope. This new dignity added nothing to the power of Boleslaus; though it increased his consequence with his own subjects. He now affected more state than before: his body-guards were considerably augmented; and he was constantly attended by a numerous and splendid retinue whenever he stirred out of his palace. Thus he inspired his people with an idea of his greatness, and consequently of their own importance; which no doubt was necessary for the accomplishment of a design he had formed, namely, an offensive war with Russia: but when he was upon the point of

setting out on this expedition, he was prevented by the breaking out of a war with the Bohemians. The elevation of Boleslaus to the regal dignity had excited the envy of the duke of Bohemia, who had solicited the same honour for himself, and had been refused. His jealousy was further excited by the connection between Boleslaus and the emperor, the former having married Rixa the emperor's niece. Without any provocation, therefore, or without giving the least intimation of his design, the duke of Bohemia entered Poland at the head of a numerous army, committing everywhere dreadful ravages. Boleslaus immediately marched against him, and the Bohemians retired with precipitation. Scarcity of provisions, and the inclemency of the season, prevented Boleslaus at that time from pursuing; but as soon as these obstacles were removed, he entered Bohemia at the head of a formidable army, with a full resolution of taking an ample revenge. The Bohemians were altogether unable to resist; neither indeed had they courage to venture a battle, though Boleslaus did all in his power to force them to it. So great indeed was the cowardice of the duke or his army, that they suffered Prague, the capital of the duchy, to be taken after a siege of two years; having never, during all that time, ventured to relieve it by fighting the Polish army. The taking of this city was quickly followed by the reduction of all the places of inferior note: but though Boleslaus was in possession of almost all the fortified places in Bohemia, he could not believe his conquests to be complete until he became master of the duke's person. This unfortunate prince had shut himself up with his son in his only remaining fortrefs of Wissfogrod, where he imagined that he should be able to foil all the attempts of the Polish monarch. In this, however, he found himself disappointed. Boleslaus invested the place, and made his approaches with such rapidity, that the garrison, dreading a general assault, resolved to capitulate, and persisted in their resolution notwithstanding all the intreaties and promises of the duke. The consequence was, that the unhappy prince fell into the hands of his enemies, and had his eyes put out by Boleslaus; after which, his son Jaremir was put into perpetual and close confinement.

12
He con-
quers Bo-
hemia

From Bohemia Boleslaus marched towards Moravia; and but no sooner did he arrive on the frontier than the whole province submitted without a blow. He then resumed his intention of invading Russia; for which he had now a very fair opportunity, by reason of a civil war which raged with violence among the children of duke Volodomir. The chief competitors were Jarislaus and Suantepolk. The latter, having been defeated by his brother, was obliged to take refuge in Poland, where he used all the arguments in his power with king Boleslaus in order to induce him to revenge his cause. Boleslaus having already an intention of invading that country, needed but little intreaty; and therefore moved towards Russia at the head of a very numerous army: giving out, that he had no other design than to revenge the injustice done to Suantepolk. He was met on the banks of the river Bog by Jarislaus at the head of an army much superior in number to his own; and for some days the Polish army was kept at bay by the Russians. At last Boleslaus, growing impatient, resolved to pass the river at all events; and therefore forming his cavalry in the best manner for breaking the torrent,

14
Gains a
great vic-
tory over
the Rus-
sians.

Poland. torrent, he exposed his own person to the utmost of its force. Encouraged by his example, the Poles advanced breast-high in the water to the opposite shore; from whence the enemy gave them all the annoyance in their power. In spite of all opposition, however, the Poles reached the bank, and soon gained a complete victory, Jarislaus being obliged to fly to Kiovia. This city was immediately invested; but Jarislaus retired farther into the country in order to recruit his army, leaving the city to its fate. The garrison made a brave defence, but were at last compelled to surrender at discretion. A vast treasure was found in the place; great part of which was distributed by Boleslaus among the soldiers.

15
Places
Suantepolk
on the
throne of
Russia,

16
Who at-
tempts to
cut him off
with his
whole ar-
my, but is
defeated.

17
A dreadful
battle be-
tween the
Russians
and Poles.

18
Saxony
conquered
by Boles-
laus,

Though the king of Poland had now become master of the greatest part of Russia, he knew that the only possible means of keeping the country in subjection was by placing a natural sovereign over the inhabitants. For this reason he reinstated Suantepolk, though his pretensions were still disputed by Jarislaus. The latter had formed a flying camp, and meditated a scheme of surprising and carrying off his rival brother; but having failed in this attempt, he retired to Novogorod, where the attachment of the inhabitants enabled him to make some resistance, till at last he was attacked and defeated by Boleslaus, which seemed to give the finishing stroke to his affairs. The king of Poland, however, now met with a more dangerous enemy in the perfidious and ungrateful Suantepolk than he had experienced in Jarislaus. The Russian prince, imagining himself a dependent on Boleslaus, formed a conspiracy against him; by which he projected nothing less than the destruction of him and his whole army. The massacre was already begun when Boleslaus received intelligence. The urgency of the case admitted of no delay: the king therefore mounted his horse; and having with the utmost haste assembled part of his army, fell upon the traitors with such fury, that they were obliged to betake themselves to flight, and Boleslaus got safe into Poland. But in the mean time Jarislaus having assembled fresh forces, pursued the Polish army; and having come up with them just as one half had crossed the river Boristhenes, attacked them with the utmost fury. Boleslaus defended himself with the greatest resolution; but, by reason of his forces being divided, victory was dubious for a long time. At last, when the army had wholly crossed, the Russians were entirely put to the rout, and a terrible carnage ensued. The victory, however, though complete, was not decisive; for which reason Boleslaus thought proper to continue his retreat, without attempting to conquer a country too extensive for him ever to keep in subjection. Still, however, his martial inclination continued, and he led his army into Saxony. The inhabitants of this country had hitherto resisted all attempts that had been made on their freedom, and still made a violent struggle for liberty; though, in spite of their utmost efforts, they were obliged at last to submit to the yoke. On his withdrawing the troops from Saxony, however, the king thought proper to leave the people to their liberty, contenting himself with a rich booty. The boundaries of his empire he now fixed at the river Elbe; where he erected two iron columns, in order to transmit the memory of his conquest to posterity.

Boleslaus, still unsated with victory, now meditated

the conquest of Prussia and Pomerania; the latter of which provinces had, in the former civil wars, been dis-
19
With Prus-
equal success against both: indeed the very terror of his name seemed to answer all the purposes of a formidable army. These, however, he seems to have designed to be the last of his warlike enterprises; for he now applied himself wholly to the enacting of wholesome laws for the benefit of his people. But in the midst of this tranquillity Jarislaus assembled the most numerous army that had ever been heard of in Russia, with which he appeared on the frontiers of Poland. Boleslaus, though now
20
Gains ano-
advanced in years, marched out against his adversaries, and met them on the banks of the Boristhenes, rendered famous by the victory he had lately gained there. The Poles crossed the river by swimming; and attacked the
21
over the
Russians,
enemy before they had time to draw up in order of battle with such impetuosity, that a total rout soon en-
22
country
sued. The Russians were seized with a panic, and Jarislaus was hurried away, and almost trampled to death by the fugitives. Many thousand prisoners were taken, but Boleslaus released them upon very easy conditions; contenting himself with an inconsiderable tribute, and endeavouring to engage the affections of the people by his kindness. This well-timed clemency produced such an happy effect, that the Russians voluntarily submitted to his jurisdiction, and again became his subjects. Soon
23
Boleslaus
after this he died in the year 1025, after having
dies.
vastly extended his dominions, and rendered his subjects happy.

Boleslaus was succeeded by his son Mieczslaus II. but he possessed none of the great qualities of his father, being indolent and debauched in his behaviour. In the very beginning of his reign, the Russians, Bohemians, and Moravians, revolted. However, as the spirit and discipline introduced by Boleslaus still remained in the Polish army, Mieczslaus found no great difficulty in reducing them again to obedience: after which, devoting himself entirely to voluptuousness, he was seized with a frenzy, which put an end to his life in the year 1034. The bad qualities of this prince proved very
24
Rixa, a ty-
detrimental to the interest of his son Casimir; though
rannical
the latter had received an excellent education, and was
regent,
possessed of many virtues. Instead of electing him king, driven out
they chose Rixa his mother queen-regent. She proved
with her
son Cafi-
tyrannical, and so partial to her countrymen the Ger-
mans, that a rebellion ensued, and she was forced to fly to Germany; where she obtained the protection of the emperor by means of the immense treasures of Boleslaus, which she had caused to be transported thither before her. Her bad behaviour and expulsion proved still more fatal to the affairs of Casimir than even that of his father. He was immediately driven out of the kingdom; and a civil war taking place, a great many pretenders to the crown appeared at once. To the miseries occasioned
25
Poland dis-
by this were added those of a foreign war; for the Bo-
stressed by
hemians and Russians invaded the kingdom in different
foreign and
places, committing the most dreadful ravages. The
domestic
consequence of these accumulated distresses was, that the nobility came at last to the resolution of recalling Casimir, and electing him sovereign. However, before they took this measure, it was thought proper to send to Rome to complain of the behaviour of the duke of Bohemia. The deputies were at first received favourably:
M m 2
but

Poland. but the influence of the duke's gold prevailing, no redress was obtained; so that at last it was resolved, without more ado, to send for Casimir.

24 Casimir recalled and erected king. The only difficulty was where to find the fugitive prince; for he had been gone five years from the kingdom, and nobody knew the place of his retreat. At last, by sending an embassy to his mother, it was found out that he had retired into France, where he applied closely to study at the university of Paris. Afterwards he went to Italy; where, for the sake of subsistence, he took upon him the monastic habit. At that time he had returned to France, and obtained some preferment in the abbey of Clugni. Nothing now obstructed the prince's return but the sacred function with which he was invested. However, a dispensation was obtained from the pope, by which he was released from his ecclesiastical engagements, on condition that he and all the kingdom should become subject to the capitation tax called *Peter-pence*. Some other conditions of less consequence were added; such as, that the Poles should shave their heads and beards, and wear a white linen robe at festivals, like other professors of the Catholic religion. Great preparations were made for the reception of the young prince: and he was met on the frontier by the nobility, clergy, and forces of the nation; by whom he was conducted to Gnesna, and crowned by the primate with more than usual solemnity. He proved a virtuous and pacific prince, as indeed the distracted situation of the kingdom would not admit of the carrying on of wars. However, Casimir proved his courage in subduing the banditti by which the country was over-run; and by marrying the prince's Mary, sister to the duke of Russia, all quarrels with that nation were for the present extinguished. Upon the whole, the kingdom flourished during his reign; and became more respectable from the wisdom and stability of the administration than it could have been by many victories. After a happy reign of 16 years, he died beloved and regretted by all his subjects.

25 Poland subjected to the tax called *Peter-pence*. By the happy administration of Casimir the kingdom recovered sufficient strength to carry on successful wars against its foreign enemies. Bolelaus II. the son of Casimir, an enterprising and valiant prince, succeeded to the throne; and soon made himself so famous, that three unfortunate princes all took refuge at his court at once, having been expelled from their own dominions by their rebellious subjects. These were, Jacomir, son of Briteflaus duke of Bohemia; Bela, brother to the king of Hungary; and Zaslaus duke of Kiovia, eldest son to Jarislaus duke of Russia, and cousin to the king of Poland. Bolelaus determined to redress all their grievances; but while he deliberated upon the most proper means for so doing, the duke of Bohemia, dreading the consequence of Jacomir's escape, assembled an army, and, without any declaration of war, marched through the Hercynian forest, desolated Silesia, and laid waste the frontiers of Poland with fire and sword. Bolelaus marched against him with a force greatly inferior; and, by mere dint of superior capacity, cooped up his adversary in a wood, where he reduced him to the greatest distress. In this extremity the duke sent proposals for accommodation; but they were rejected with disdain by Bolelaus; upon which the former, ordering fires to be kindled in his camp, as if he designed to continue there, removed with the utmost silence in the night-time;

and marching through narrow defiles, was advanced several leagues before Bolelaus received advice of his retreat. The king pursued him, but in vain; for which reason he returned, after having ravaged the frontiers of Moravia. The next year he entered Bohemia with a numerous army; but the duke, being unwilling to encounter such a formidable adversary, submitted to such terms as Bolelaus thought proper to impose. In these the king of Poland stipulated for certain conditions in favour of Jacomir, which he took care to see punctually executed; after which he determined to march towards Hungary, to assist the fugitive prince Bela.

29 And to Bela prince of Hungary. This prince had been for some time solicited by a party of disaffected nobility to return, as his brother, the reigning king, had alienated the hearts of his subjects by his tyrannical behaviour: as soon therefore as Bolelaus had finished the war in Bohemia, he was solicited by Bela to embrace so favourable an opportunity, and put him in possession of the kingdom of Hungary. This the king readily complied with, as being agreeable to his own inclinations; and both princes entered Hungary by different routes, each at the head of a numerous body. The king of that country, however, was not disconcerted by such a formidable invasion; and being largely assisted by the emperor, advanced against his antagonists with a vast army; among whom was a numerous body of Bohemians, who had come to his assistance, though in direct violation of the treaty subsisting between the duke and the king of Poland. At last a decisive battle was fought, in which the Germans behaved with the greatest valour, but were entirely defeated through the treachery of the Hungarians, who in the heat of the battle deserted and went over to Bela. Almost all the foreign auxiliaries were killed on the spot; the king himself was seized, and treated with such insolence by his perfidious subjects, that he died in a short time of a broken heart; so that Bela was placed on the throne without further opposition, except from a revolt of the peasants, which was soon quelled by the Polish army.

30 He projects the conquest of Russia. Bolelaus, having succeeded so happily in these two enterprises, began to look upon himself as invincible; and, instead of designing only to assist Zaslaus, as he had first intended, now projected no less than the subjection of the whole country. He had indeed a claim to the sovereignty by virtue of his descent from Mary, queen of Poland, sister to Jarislaus; and this he endeavoured to strengthen by marrying a Russian prince's himself. Having therefore assembled a very numerous and well-disciplined army, he entered the duchy of Kiovia, where he was opposed by Wisseflaus, who had usurped the sovereignty, with a vast multitude of forces. Bolelaus, however, continued to advance; and the Russian prince being intimidated by the number and good order of his enemies, deserted his own troops, and fled away privately with a slender retinue; upon which his force dispersed themselves for want of a leader. The inhabitants of the city of Kiovia now called to their assistance Suantoflaus and Wizevold two brothers of Wisseflaus; but these princes acting the part of mediators, procured pardon for the inhabitants from Zaslaus their natural sovereign. With the same facility the two princes recovered all the other dominions belonging to Zaslaus; only one city venturing to stand a siege, and that was soon reduced. But in the mean time the king

Poland.

And to Bela prince of Hungary.

He projects the conquest of Russia.

Meets with surprising success.

Poland

of Hungary dying, a revolt ensued, and the two sons of Bela were on the point of being deprived of their paternal dominions. This Boleslaus no sooner heard than he marched directly into Hungary; where by the bare terror of his name, he re-established tranquillity, and confirmed the princes in the enjoyment of their kingdom. In the time that this was doing, Zaslau was again driven from his territories, all the conquests that had been formerly made were lost, and Suantoflaus and Wizevold more powerful than ever. The king's vigour, however, soon disconcerted all their measures. He ravaged all those territories which composed the palatinates of Lufac and Chelm, reduced the strong city of Wolyn, and transported the booty to Poland. The campaign was finished by a battle with Wizevold; which proved so bloody, that though Boleslaus was victorious, his army was weakened in such a manner that he could not pursue his conquests. In the winter he made numerous levies; and returning in the spring to Kiovia, reduced it, after several desperate attacks, by famine. On this occasion, instead of treating the inhabitants with cruelty, he commended their valour, and strictly prohibited his troops from pillaging or insulting them; distributing provisions among them with the utmost liberality.

32
Reduces
Kiovia, but
enervates
himself
there.

33
Universal
defection
of the Po-
lish wo-
men.

This clemency procured the highest honour to the king of Poland; but his stay here produced a most terrible disaster. Kiovia was the most dissolute, as well as the richest city, in the north; the king and all his soldiers gave themselves up to the pleasures of the place. Boleslaus himself affected all the imperious state of an eastern monarch, and contracted an inclination for the grossest debaucheries. The consequence had almost proved fatal to Poland. The Hungarian and Russian wars had continued for seven years, during all which time the king had never been at home excepting once for the short space of three months. In the mean time the Polish women, exasperated at hearing that their husbands had neglected them and connected themselves with the women of Kiovia, raised their slaves to the beds of their masters; and in short the whole sex conspired in one general scheme of prostitution, in order to be revenged of the infidelity of their husbands, excepting one single woman, namely, *Margaret*, the wife of Count Nicholas of Demboisin, who preserved her fidelity in spite of all solicitation. Advice of this strange revolution was soon received at Kiovia, where it excited terrible commotions. The soldiers blamed the king for their dishonour; forgetting how much they had to accuse their own conduct in giving their wives such extreme provocation. The effect of these discontents was a general desertion, and Boleslaus saw himself suddenly left almost alone in the heart of Russia; the soldiers having unanimously resolved to return home to take vengeance of their wives and their gallants.

34
A terrible
civil war
ensues.

A dreadful kind of war now ensued. The women knew that they were to expect no mercy from their enraged husbands, and therefore persuaded their lovers to take arms in their defence. They themselves fought by the side of their gallants with the utmost fury, and fought out their husbands in the heat of battle, in order to secure themselves from all danger of punishment by their death. They were, however, on the point of being subdued, when Boleslaus arrived with the few remaining Poles, but assisted by a vast army of Russians,

with whom he intended to take equal vengeance on the women, their gallants, and his own soldiers who had deserted him. This produced a carnage more dreadful than ever. The soldiers united with their former wives and their gallants against the common enemy, and fought against Boleslaus and his Russians with the fury of lions. At last, however, the fortune of the king prevailed; the rebels were totally subdued, and the few who escaped the sword were tortured to death, or died in prison.

Poland.

To add to the calamities of this unhappy kingdom, Religious the schisms which for some time had prevailed in the church of Rome found their way into Poland also; and

the animosity of parties became aggravated in proportion to the frivolousness of their differences. By perverse accident the matter came at last to be a contention for wealth and power between the king and clergy. This soon gave occasion to bloodshed; and the bishop of Cracow was massacred in the cathedral while he was performing the duties of his office. This and some other enormous crimes in a short time brought on the most signal vengeance of the clergy. Gregory VII. the pope at that time, thundered out the most dreadful anathemas against the king, released his subjects from their allegiance, deprived him of the titles of sovereignty, and laid the kingdom under a general interdict, which the archbishop of Gnesna saw punctually enforced. To this terrible sentence Boleslaus in vain opposed his authority, and recalled the spirit which had formerly rendered him so formidable to the neighbouring states. The minds of the people were blinded by superstition, so that they deemed it a less heinous crime to rise in rebellion against their sovereign than to oppose the tyranny of the holy see. Conspiracies were daily formed against the person and government of Boleslaus. The whole kingdom became a scene of confusion, so that the king could no longer continue with safety in his own dominions. He fled therefore with his son Miecslaus, and took refuge in Hungary; but here also the holy vengeance of the clergy pursued him, nor did they cease persecuting him till he was brought to a miserable end. Authors differ widely with respect to the manner of his death. Some say that he was murdered by the clergy as he was hunting; others, that he killed himself in a fit of despair; and one author tells us, that he wandered about in the woods of Hungary, lived like a savage upon wild beasts, and was at last killed and devoured by dogs. The greatest number, however, tell us, that being driven from place to place by the persecutions of the clergy, he was at last obliged to become a cook in a monastery at Carinthia, in which mean occupation he ended his days.

37
The king's
extreme
distress,
and
death.

The destruction of Boleslaus was not sufficient to allay the papal resentment. It extended to the whole kingdom of Poland. Miecslaus, the son of Boleslaus, was not suffered to ascend the throne; and the kingdom continued under the most severe interdict, which could be removed only by the force of gold, and the most abject concessions. Besides the tax called *Peter-pence*, new impositions were added of the most oppressive nature; till at length the pontiff, having satiated his avarice, and impoverished the country, consented that the brother of the deceased monarch should be raised to the sovereignty, but only with the title of duke. This prince, named *Uladislaus*, being of a meek disposition,

with

Poland.

39
 Uladislaus becomes sovereign, but is allowed only the title of duke.

with little ambition, thought it his duty to acquiesce implicitly in the will of the pope; and therefore accepted the terms offered, sending at the same time an embassy to Rome, earnestly intreating the removal of the interdict. The request was granted; but all his endeavours to recover the regal dignity proved fruitless, the pope having, in conjunction with the emperor of Germany, conferred that honour on the duke of Bohemia. This was extremely mortifying to Uladislaus, but it was absorbed in considerations of the utmost consequence to himself and his dominions. Russia took the opportunity of the late civil disturbances to throw off the yoke; and this revolt drew after it the revolt of Prussia, Pomerania, and other provinces. The smaller provinces, however, were soon reduced; but the duke had no sooner returned to Poland, than they again rebelled, and hid their families in impenetrable forests. Uladislaus marched against them with a considerable army; but was entirely defeated, and obliged to return back with disgrace. Next year, however, he had better fortune; and, having led against them a more numerous army than before, they were content to submit and deliver up the ringleaders of the revolt to be punished as the duke thought proper.

No sooner were the Pomeranians reduced, than civil dissensions took place. Sbigneus, the son of Uladislaus by a concubine, was placed at the head of an army by the discontented nobility, in order to subvert his father's government, and dispute the title of Boleslaus, the legitimate son of Uladislaus, to the succession. The war was terminated by the defeat and captivity of Sbigneus; who was at first confined, but afterwards released on condition that he should join his father in punishing the palatine of Cracow. But before this could be done, the palatine found means to effect a reconciliation with the duke; with which the young princes being displeased, a war took place between them and their father. The end of all was, that the palatine of Cracow was banished, and the princes submitted; after which, Uladislaus, having chastised the Prussians and Pomeranians who had again revolted, died in the year 1103, the 59th of his age.

40
 Boleslaus III. divided his dominions betwixt Sbigneus his illegitimate brother and himself.

41
 A civil war.

42
 Generosity of Boleslaus, and in gratitude of Sbigneus,

Uladislaus was succeeded by his son Boleslaus III. who divided the dominions equally betwixt his brother Sbigneus and himself. The former being dissatisfied with his share, raised cabals against his brother. A civil war was for some time prevented by the good offices of the primate: but at last Sbigneus, having privately stirred up the Bohemians, Saxons, and Moravians, against his brother, made such formidable preparations as threatened the conquest of all Poland. Boleslaus, being unprovided with forces to oppose such a formidable power, had recourse to the Russians and Hungarians; who readily embraced his cause, in expectation of turning it to their own advantage. The event was, that Sbigneus was entirely defeated; and might easily have been obliged to surrender himself at discretion, had not Boleslaus generously left him in quiet possession of the duchy of Mazovia, in order to maintain himself suitably to the dignity of his birth. This kindness the ungrateful Sbigneus repaid by entering into another conspiracy; but the plot being discovered, he was seized, banished, and declared a traitor if ever he set foot again in Poland. Even this severity did not produce the desired effect: Sbigneus persuaded the Pomeranians to

arm in his behalf; but he was defeated, taken prisoner, and again banished. Almost all the nobility solicited the king to put such an ungrateful traitor to death; however, that generous prince could not think of polluting his hands with the death of his brother, notwithstanding all he had yet done. Nay, he even took him back to Poland, and appointed him a maintenance suitable to his rank: but he soon had reason to repent his kindness; for his unnatural brother in a short time began to raise fresh disturbances, in consequence of which he soon met with the death which he deserved.

Boleslaus was scarce freed from the intrigues of his brother, when he found himself in greater danger than ever from the ambition of the emperor Henry IV. The emperor had attacked the king of Hungary, with whom Boleslaus was in close alliance, and from whom he had received assistance when in great distress himself. The king of Poland determined to assist his friend; and therefore made a powerful diversion in Bohemia, where he repeatedly defeated the Imperialists: upon which, the emperor collecting all his forces, ravaged Silesia, and even entered Poland, where he laid siege to the strong town of Lubusz; but was at last obliged to abandon the enterprise, after having sustained much loss. However, Henry was not discouraged, but penetrated still farther into Poland, and was laying waste all before him, when the superior skill of Boleslaus compelled him to retire, after having almost destroyed his army with fatigue and famine, without once coming to action. Enraged at this disappointment, Henry laid siege to Glogaw, in hopes of drawing the Poles to an engagement before he should be obliged to evacuate the country. The fortifications of the place were weak; but the spirit of the inhabitants supplied their deficiencies, and they gave the Imperialists a most unexpected and vigorous reception. At last, however, they were on the point of surrendering to superior force; and actually agreed to give up the place, provided they did not receive any succours during that time. Boleslaus determined, however, not to let such a brave garrison fall a sacrifice to their loyalty; and therefore prevailed on the besieged to break the capitulation rather than surrender when they were on the point of being delivered. All this was transacted with the utmost secrecy; so that the emperor advanced, without thoughts of meeting with any resistance, to take possession of the city; but, being received by a furious discharge of arrows and javelins, he was so incensed, that he resolved to storm the place, and give no quarter. On the approach of the army, the Imperialists were astonished to see not only the breaches filled up, but new walls, secured by a wet ditch, reared behind the old, and erected during the suspension of hostilities by the industry of the besieged. The attack, however, went on; but the inhabitants, animated by despair, defended themselves with incredible valour, and at last obliged the Imperialists to break up the siege with precipitation. Next day Boleslaus arrived, and pursued the emperor with such vigour, that he obliged him to fly with disgrace into his own country. This soon brought on a peace, which was confirmed by a marriage between Boleslaus and the emperor's sister.

Hitherto the glory of Boleslaus had equalled, or even eclipsed, that of his namesake and predecessor Boleslaus the Great; but about the year 1135 he was brought

Poland.

43
 Who is at last put to death.

44
 War with the emperor Henry IV.

45
 Who is worsted.

46
 Boleslaus brought into disrepute by his own credulity and general

Poland.

brought into difficulties and disgrace by his own credulity. He was imposed upon by an artful story patched up by a certain Hungarian; who insinuated himself so far into his affections, that he gave him the government of Wislica, a strong town on the river Nida. But the traitor gave up the place to the Russians, who pillaged and burnt it; carrying the inhabitants at the same time into slavery. Boleslaus was incensed, and entered immediately upon a war with Russia, by which means he only heaped one calamity upon another. He received a deputation from the inhabitants of Halitz, to implore his assistance in favour of a young prince, who had been banished into Poland. Boleslaus marched to their relief with a choice body of troops; but as he was preparing to enter the town, he was attacked by the whole Russian army, and, after a most violent conflict, entirely defeated. By this disgrace the duke was so much afflicted, that he died in a short time, after having reigned 36 years.

47
Poland divided among the children of Boleslaus.

Boleslaus, by his will, left his dominions equally divided among his four sons. Uladislaus, the eldest, had the provinces of Cracow, Sirad, Lencici, Silesia, and Pomerania. Boleslaus, the second son, had for his share the palatinates of Culm and Cujava, with the duchy of Mazovia. The palatinates of Kaleszh and Posenia fell to Mieczslaus the third son; and to Henry, the fourth son, were assigned those of Lublin and Sandomir. Casimir the youngest child, then an infant in the cradle, was entirely forgot, and no provision made for him. There have been but very few instances where dominions were thus divided, that the princes remained satisfied with their respective shares; neither did the sons of Boleslaus long continue at peace with one another. By the will of the late duke, all the brothers were obliged to own the supremacy of Uladislaus, who was declared duke of all Poland: they were restrained from forming alliances, declaring war, or concluding peace, without his approbation: they were obliged to take the field with a certain number of troops, whenever the duke required it; and they were forbid to meddle with the guardianship of the infant prince Casimir, his education being left entirely to the sovereign. The harmony of the princes was first disturbed by the ambition of Christina, the wife of Uladislaus, who formed a scheme to get possession of all Poland, and deprive the younger children of the benefit of their father's will. Having obtained her husband's concurrence, she assembled the states of Poland, and made a long speech, showing the dangers which might arise from a partition of the ducal dominions among so many; and concluded with attempting to show the necessity of revoking the ratification of the late duke's will, in order to ensure the obedience of the princes and the tranquillity of the republic. Many of the nobility expressed their resentment against this speech, and fully refuted every article in it; but they were all afterwards gained over, or intimidated by Uladislaus; so that none appeared to take the part of the young princes except a noble Dane, who lost his life for so doing.

48
A civil war.

49-
Uladislaus drives out all the rest.

Uladislaus now having got the nobility on his side, first drove Boleslaus out of his territories; next, he marched against Henry, and dispossessed him also, forcing both to take refuge with Mieczslaus in Posenia, where all the three brothers were besieged. Several of the nobility interposed, and used all their influence to

effect a reconciliation, but in vain; for Uladislaus was as inexorable as if he had received an injury, and therefore insisted that the besieged princes should surrender at discretion, and submit to the will of the conqueror. Thus driven to despair, the brothers sallied out, and attacked the duke's army with such impetuosity, that they obtained a complete victory, and took all his baggage and valuable effects. The brothers improved their victory, and laid siege to Cracow. The Russians, who had assisted Uladislaus at first, now entirely abandoned him, and evacuated Poland, which obliged him to shut himself up in Cracow; but, finding the inhabitants little disposed to stand a siege, he retired into Germany in order to solicit assistance from his wife's friends. But here he found himself mistaken, and that these friends were attached to him only in his prosperity; while in the mean time the city of Cracow surrendered, the unfortunate Uladislaus was formally deposed, and his brother Boleslaus raised to the supreme authority.

Poland.

The new duke began his administration with an act of generosity to his brother Uladislaus, to whom he gave the duchy of Silesia, which thus was separated from Poland, and has never since been re-annexed to it. This had no other effect upon Uladislaus than the putting him in a condition to raise fresh disturbances; for he now found means to persuade the emperor Conrad to invade Poland: but Boleslaus so harassed and fatigued his army by perpetual marches, ambuscades, and skirmishes, that he was obliged in a short time to return to his own country; and for some years Poland enjoyed a profound tranquillity.

During this interval Henry entered on a crusade; and, though he lost almost all his army in that enthusiastic undertaking, he is celebrated by the superstitious writers of that age, as the bulwark of the church, and one of the greatest Christian heroes: however, in all probability, the reason of this extraordinary fame is, that he made large donations to the knights of St John of Jerusalem. Soon after the return of Henry, Poland was invaded by the emperor Frederic Barbarossa, who was persuaded to this by the solicitations of Uladislaus and his wife Christina. The number of the Imperialists was so great, that Boleslaus and his brothers did not think proper to oppose them in the field; they contented themselves with cutting off the convoys, placing ambuscades, harassing them on their march, and keeping them in perpetual alarms by false attacks and skirmishes. With this view the three brothers divided their forces, desolated the country before the enemy, and burnt all the towns and cities which were in no condition to stand a siege. Thus the emperor, advancing into the heart of a desolated country where he could not subsist, was at last reduced to such a situation that he could neither go forward nor retreat, and was obliged to solicit a conference with Boleslaus. The latter was too prudent to irritate him by an unreasonable haughtiness, and therefore went to the German camp attended only by his brothers and a slight guard. This instance of confidence was so agreeable to the emperor, that a treaty was soon agreed upon, which was confirmed by a marriage between Adelaide, niece to the emperor, and Mieczslaus duke of Posenia.

Boleslaus having thus happily escaped from so great a danger, took it into his head to attempt the conquest of Prussia, for no other reason but because the inhabitants

50
And is deposed.

51
Poland invaded by the emperor Barbarossa.

52
Who is obliged to sue for peace.

Poland.

tants were heathens. Having unexpectedly invaded the country with a very numerous army, he succeeded in his enterprise; great numbers of infidels were converted, and many churches set up: but no sooner was Boleslaus gone, than the inhabitants returned to their old religion. Upon this Boleslaus again came against them with a formidable power; but, being betrayed by some Prussians whom he had taken into his service and raised to posts of honour, his army was led into desiles and almost entirely cut off, duke Henry was killed, and Boleslaus and Miecslaus escaped with great difficulty.

53
A civil
war.

This misfortune was quickly followed by another; for now the children of Uladislaus laid claim to all the Polish dominions which had been possessed by their father, most of which had been bestowed upon young Casimir. They were supported in their pretensions by a great number of discontented Poles, and a considerable body of German auxiliaries. Boleslaus, finding himself unable to withstand his enemies by force, had recourse to negociation, by which means he gained time to recruit his army and repair his losses. An assembly of the states was held, before which the duke so fully refuted the claims of the children of Uladislaus, that it was almost unanimously voted that they had kindled an unjust war; and to take away every pretence for renewing the civil discords of Poland, they were a second time invested with the duchy of Silesia, which for the present put an end to all disputes. After this, Boleslaus applied himself to promote, by all means, the happiness of his subjects, till his death, which happened in the year 1174.

On the death of Boleslaus, the states raised his brother Miecslaus to the ducal throne, on account of the great opinion they had of him. But the moment that Miecslaus ceased to be a subject, he became a tyrant, and a slave to almost every kind of vice; the consequence of which was, that in a very short time he was deposed, and his brother Casimir elected in his stead.

54
Casimir, an
excellent
prince,

Casimir was a prince of the greatest justice and benevolence, inasmuch that he scrupled to accept of the honour which the states had conferred upon him, lest it should be a trespass against the laws of equity. However, this scruple being soon got over, he set himself about the securing peace and tranquillity in all parts of his dominions. He redressed all grievances, suppressed exorbitant imposts, and assembled a general diet, in which it was proposed to rescue the peasants from the tyranny of the nobility; an affair of such consequence, that the duke could not enter upon it by his own authority, even though supported by the clergy. Yet it proved less difficult than had been imagined, to persuade the nobility to relinquish certain privileges extremely detrimental to natural right. They were influenced by the example of their virtuous sovereign, and immediately granted all that he required; and, to secure this declaration in favour of the peasants, the archbishop of Gnesna thundered out anathemas against those who should endeavour to regain the unjust privileges which they had now renounced; and to give a still greater weight to this decision, the acts of the diet were transmitted to Rome, where they were confirmed by the pope.

But though the nobility in general consented to have their power somewhat retrenched, it proved matter of discontent to some, who for this reason immediately became the partisans of the deposed Miecslaus. This un-

fortunate prince was now reduced to such indigence, that he wrote an account of his situation to his brother Casimir; which so much affected him, that in an assembly of the diet he proposed to resign the sovereignty in favour of his brother. To this the states replied in the most peremptory manner: they desired him never more to mention the subject to them, lest they should be under the necessity of deposing him and excluding his brother, who, they were determined, should never more have the dominion of Poland. Casimir, however, was so much concerned at the account of his brother's misfortunes, that he tried every method to relieve him, and even connived at the arts practised by some discontented noblemen to restore him. By a very singular generosity, he facilitated the reduction of Gnesna and Lower Poland, where Miecslaus might have lived in peace and splendor, had not his heart been so corrupted that it could not be subdued by kindness. The consequence was, that he used all his art to wrest from his brother the whole of his dominions, and actually conquered the provinces of Mazovia and Cujava; but of these he was soon dispossessed, and only some places in Lower Poland were left him. After this he made another attempt, on occasion of a report that Casimir had been poisoned in an expedition into Russia. He surprised the city of Cracow: but the citadel refused to surrender, and his hopes were entirely blasted by the return of Casimir himself; who, with an unparalleled generosity and magnanimity, asked peace of his brother whom he had vanquished and had in a manner at his mercy.—The last action of this amiable prince was the conquest of Russia, which he effected rather by the reputation of his wisdom and generosity than by the force of his arms. Those barbarians voluntarily submitted to a prince so famed for his benevolence, justice, and humanity. Soon after his return, he died at Cracow, lamented as the best prince in every respect who had ever filled the throne of Poland.

Poland.

Casimir left one son, named *Lechus*, an infant; and the states, dreading the consequences of a long minority, hesitated at appointing him sovereign, considering how many competitors he must necessarily have, and how dubious it must be whether he might be fit for the sovereignty after he had obtained it. At last, however, *Lechus* was nominated, chiefly through the interest he had obtained on account of the reputation of his father's virtues. The consequence of his nomination was precisely what might have been expected. Miecslaus formed an alliance against him with the dukes of Opelen, Pomerania, and Bresslau; and having raised all the men in Lower Poland fit to bear arms, took the road to Cracow with a very numerous army. A bloody battle was fought on the banks of the river *Mozgarva*; in which both sides were so much weakened, that they were unable to keep the field, and consequently were forced to retire for some time in order to repair their forces. Miecslaus was first ready for action, and therefore had the advantage: however, he thought proper to employ artifice rather than open force; and therefore having attempted in vain to corrupt the guardians of *Lechus*, he entered into a treaty with the duchess-dowager his mother. To her he represented in the strongest manner the miseries which would ensue from her refusal of the conditions he proposed. He stipulated to adopt *Lechus* and *Conrade*, her sons, for his own; to

55
Conquer
Russia.

56
Civil war
between
Lechus and
the deposed
Miecslaus.

Poland.
57
Mieczslaus
restored.

surrender the province of Cujavia for their present support; and to declare them heirs to all his dominions. The principal nobility opposed this accommodation, but it was accepted by the dukes in spite of all their remonstrances; and Mieczslaus was once more put in possession of the capital, after having taken a solemn oath to execute punctually every article of the treaty.

It is not to be supposed that a prince of such a perfidious disposition as Mieczslaus would pay much regard to the obligations of a simple contract. It was a maxim with him, that a sovereign is no longer obliged to keep his oath than while it is neither safe nor beneficial to break it. Having therefore got all the power into his hands, he behaved in the very same manner as if no treaty with the dukes had subsisted. The dukes, perceiving herself duped, formed a strong party, and excited a general insurrection. The rebellion could not be withstood: Mieczslaus was driven out of Cracow, and on the point of being reduced to his former circumstances, when he found means to produce a variance between the dukes and palatine of Cracow; and thus once more turned the scale in his favour. The forces of Mieczslaus now became superior, and he, in consequence, regained possession of Cracow, but did not long enjoy his prosperity, falling a victim to his intemperance; so that Lechus was restored to the sovereignty in the year 1206.

58
Poland ravaged by
the Tartars.

The government of Lechus was the most unfortunate of any of the sovereigns of Poland. In his time the Tartars made an irruption, and committed everywhere the most cruel ravages. At last they came to an engagement with the Poles, assisted by the Russians; and after an obstinate and dreadful conflict, obtained a complete victory. This incursion, however, terminated as precipitately as it commenced; for without any apparent reason they retired, just as the whole kingdom was ready to submit; but the devastations they had committed produced a famine, which was soon followed by a plague that depopulated one of the most populous countries of the north. In this unhappy situation of affairs, death ended the misfortunes of Lechus, who was murdered by his own subjects as he was bathing. A civil war took place after his death; and the history for some time is so confused, that it is difficult to say with certainty who was his successor. During this unfortunate state of the country, the Tartars made a second irruption, laid all desolate before them, and were advancing to the capital, when they were attacked and defeated with great slaughter by the palatine of Cracow with only a handful of men. The power of the enemy, however, was not broken by this victory; for, next year, the Tartars returned, and committed such barbarities as can scarce be imagined. Whole provinces were defeated, and every one of the inhabitants massacred. They were returning, laden with spoil, when the palatine fell upon them a second time, but not with the same success as before: for, after an obstinate engagement, he was defeated, and thus all Poland was laid open to the ravages of the barbarians; the nobility fled into Hungary, and the peasants sought an asylum among rocks and impenetrable forests. Cracow, being left entirely defenceless, was soon taken, pillaged, and burnt; after which the barbarians, penetrating into Silesia and Moravia, desolated these countries, destroying Breslau and other cities. Nor did Hungary escape the

VOL. XV. Part I.

fury of their barbarity: the king gave battle to the Tartars, but was defeated with vast slaughter, and had the mortification to see his capital laid in ashes, and above 100,000 of his subjects perish by fire and sword. The arms of the Tartars were invincible; nothing could withstand the prodigious number of forces which they brought into the field, and the fury with which they fought. They fixed their head-quarters on the frontiers of Hungary; and spread their devastations on every side with a celerity and success that threatened the destruction of the whole empire, as well as of the neighbouring kingdoms.

In this dreadful situation was Poland when Boleslaus, surnamed the *Chaste*, was raised to the sovereignty; but this, so far from putting an end to the troubles, only superadded a civil war to the rest of the calamities. Boleslaus was opposed by his uncle Conrade the brother of Lechus, who was provoked at becoming the subject of his own nephew. Having assembled a powerful army, he gained possession of Cracow; assumed the title of *Duke of Poland*; and might possibly have kept possession of the sovereignty, had not his avarice and pride equally offended the nobility and peasants. In consequence of their discontents, they unanimously invited Boleslaus, who had fled into Hungary, to come and head the insurrection which now took place in every quarter. On his arrival, he was joyfully received into the capital: but Conrade still headed a powerful party; and it is reported that on this occasion the knights of the Teutonic order were first called into Poland, to dispute the pretensions of Boleslaus. All the endeavours of Conrade, however, proved unsuccessful: he was defeated in two pitched battles, and forced to live in a private situation; though he never ceased to harass his nephew, and make fresh attempts to recover the crown. However, of the reign of Boleslaus we have little account, except that he made a vow of perpetual continency, and imposed the same on his wife; that he founded near 40 monasteries; and that he died after a long reign in 1279, after having adopted Lechus duke of Cujavia, and procured a confirmation of his choice by the free election of the people.

59
Knights of
the Teuto-
nic order
first called
into Po-
land.

The reign of this last prince was one continued scene of foreign and domestic trouble. On his first accession he was attacked by the united forces of Russia and Lithuania assisted by the Tartars; whom, however, he had the good fortune to defeat in a pitched battle. By this victory the enemy were obliged to quit the kingdom; but Lechus was so much weakened, that civil dissensions took place immediately after. These increased to such a degree, that Lechus was obliged to fly to Hungary, the common resource of distressed Polish princes. The inhabitants of Cracow alone remained firm in their duty; and these brave citizens stood all the fatigue and danger of a tedious siege, till they were at last relieved by Lechus at the head of an Hungarian army, who defeated the rebels, and restored to his kingdom a legitimate government. He had scarce reascended the throne when the united forces of the Russians, Tartars, and Lithuanians, made a second irruption into Poland, and desolated the country with the most savage barbarity. Their forces were now rendered more terrible than ever by their having along with them a vast number of large dogs trained to the art of war. Lechus, however, with an army much inferior, obtained a complete victory;

N n

victory;

Poland.

victory; the Poles being animated by despair, as perceiving, that, if they were conquered, they must also be devoured. Soon after this, Lechus died with the reputation of a warlike, wife, but unfortunate prince. As he died without issue, his crown was contested, a civil war again ensued; and the affairs of the state continued in a very declining way till the year 1296, when Premislaus, the duke at that time, resumed the title of king. However, they did not revive in any considerable degree till the year 1305, when Uladislaus Locticus, who had seized the throne in 1300, and afterwards been driven out, was again restored to it. The first transaction of his reign was a war with the Teutonic knights, who had usurped the greater part of Pomerania during the late disturbances. They had been settled in the territory of Culm by Conrad duke of Mazovia; but soon extended their dominion over the neighbouring provinces, and had even got possession of the city of Dantzic, where they massacred a number of Pomeranian gentlemen in cold blood; which so much terrified the neighbouring towns, that they submitted without a stroke. The knights were commanded by the Pope himself to renounce their conquests; but they set at nought all his thunders, and even suffered themselves to be excommunicated rather than part with them. As soon as this happened, the king marched into the territories of the marquis of Brandenburg, because he had pretended to sell a right to the Teutonic knights to those countries, when he had none to them himself. Uladislaus next entered the territory of Culm, where he laid every thing waste with fire and sword; and, being opposed by the joint forces of the marquis, the knights, and the duke of Mazovia, he obtained a complete victory after a desperate and bloody engagement. Without pursuing the blow, he returned to Poland, recruited his army, and being reinforced by a body of auxiliaries from Hungary and Lithuania, he dispersed the enemy's forces, and ravaged a second time all the dominions of the Teutonic order. Had he improved this advantage, he might easily have exterminated the whole order, or at least reduced them so low, that they could never have occasioned any more disturbances in the state; but he suffered himself to be soothed and cajoled by the promises which they made without any design of keeping them, and concluded a treaty under the mediation of the kings of Hungary and Bohemia. In a few months he was convinced of the perfidy of the knights; for they not only refused to evacuate Pomerania as had been stipulated in the treaty, but endeavoured to extend their usurpations, for which purpose they had assembled a very considerable army. Uladislaus, enraged at their treachery, took the field a third time, and gave them battle with such success, that 4000 knights were left dead on the spot, and 30,000 auxiliaries killed or taken prisoners. Yet, though the king had it once more in his power to destroy the whole Teutonic order, he satisfied himself with obtaining the territories which had occasioned the war; after which he spent the remainder of his life in peace and tranquillity.

62
Russia Ni-
gra con-
quered by
Casimir the
Great.

Uladislaus was succeeded by his son Casimir III. surnamed the Great. He subdued the province called *Russia Nigra* in a single campaign. Next he turned his arms against Mazovia; and with the utmost rapidity over-ran the duchy, and annexed it as a province to the crown: after which he applied himself to domestic af-

fairs, and was the first who introduced a written code of laws into Poland. He was the most impartial judge, the most rigid observer of justice, and the most submissive to the laws, of any potentate mentioned in the history of Europe. The only vice with which he is charged is that of incontinency; but even this the clergy declared to be a venial sin, and amply compensated by his other virtues, particularly the great liberality which he showed to the clerical order.

Poland.

Casimir was succeeded in 1370 by his nephew Louis king of Hungary; but, as the Poles looked upon him to be a foreign prince, they were not happy under his administration. Indeed a coldness between this monarch and his people took place even before he ascended the throne; for in the *pacta conventa*, to which the Polish monarchs were obliged to swear, a great number of unusual articles were inserted. This probably was the reason why he left Poland almost as soon as his coronation was over, carrying with him the crown, sceptre, globe, and sword of state, to prevent the Poles from electing another prince during his absence. He left the government in the hands of his mother Elizabeth; and she would have been agreeable to the people, had her capacity for government been equal to the task. At that time, however, the state of Poland was too much distracted to be governed by a woman. The country was over-run with bold robbers and gangs of villains, who committed the most horrid disorders; the kingdom was likewise invaded by the Lithuanians; the whole province of Russia Nigra revolted; and the kingdom was universally filled with dissension. The Poles could not bear to see their towns filled with Hungarian garrisons; and therefore sent a message to the king, telling him that they thought he had been sufficiently honoured in being elected king of Poland himself, without suffering the kingdom to be governed by a woman and his Hungarian subjects. On this Louis immediately raised a numerous army, with a design fully to conquer the spirit of his subjects. His first operations were directed against the Russians; whom he defeated, and again reduced to subjection. Then he turned his arms against the Lithuanians, drove them out of the kingdom, and re-established public tranquillity. However, instead of being satisfied with this, and removing the Hungarian garrisons, he introduced many more, and raised Hungarians to all the chief posts of government. His credit and authority even went so far as to get a successor nominated who was disagreeable to the whole nation, namely *Sigismund* marquis of Brandenburg. After the death of Louis, however, this election was set aside; and Hedwiga, daughter of Casimir the Great, was proclaimed queen.

63
Unhappy
reign of
Louis.

This princess married Jagello duke of Lithuania, who was now converted to Christianity, and baptized by the name of *Uladislaus*. In consequence of this marriage, the duchy of Lithuania, as well as the vast provinces of Samogitia and Russia Nigra, became annexed to the crown of Poland. Such a formidable accession of power excited the jealousy of the Teutonic knights, who were sensible that Uladislaus was now bound to undertake the reduction of Pomerania, and revenge all the injuries which Poland had sustained from them for a great number of years. From his first accession therefore they considered this monarch as their greatest enemy, and endeavoured to prevent his designs against them by effect-

64
Hedwiga
marries the
duke of Li-
thuania,
thereby
uniting that
duchy, to-
gether with
Samogitia
and Russia
Nigra, to
Poland.

Poland. ing a revolution in Lithuania in favour of his brother Andrew. The prospect of success was the greater here, as most of the nobility were discontented with the late alliance, and Uladislaus had proposed to effect a revolution in religion, which was highly disagreeable. On a sudden, therefore, two armies marched towards the frontiers of the duchy, which they as suddenly penetrated, laying waste the whole country, and seizing upon some important fortresses before the king of Poland had any notice of the matter. As soon as he received advice of these ravages, Uladislaus raised some forces with the utmost celerity, which he committed to the care of his brother Skirgello, who defeated the Teutonic knights, and soon obliged them to abandon all their conquests. In the mean time Uladislaus marched in person into the Higher Poland, which was subjected to a variety of petty tyrants, who oppressed the people, and governed with intolerable despotism. The palatine of Posnia in particular had distinguished himself by his rebellious practices; but he was completely defeated by Uladislaus, and the whole country reduced to obedience.

65
Troubles in Lithuania. Having secured the tranquillity of Poland, Uladislaus visited Lithuania, attended by a great number of the clergy, in order to convert his subjects. This he effected without great difficulty; but left the care of the duchy to his brother Skirgello, a man of a cruel, haughty, and debauched turn, and who immediately began to abuse his power. With him the king sent his cousin Vitowda, a prince of a generous, brave, and amiable disposition, to be a check upon his conduct; but the barbarity of Skirgello soon obliged this prince to take refuge among the Teutonic knights, who were now become the asylum of the oppressed and discontented. For some time, however, he did not assist the knights in their designs against his country; but having applied for protection to the king, and finding him remiss in affording the necessary assistance, he at last joined in the schemes formed by the knights for the destruction of Poland. Entering Lithuania at the head of a numerous army, he took the capital, burnt part of it, and destroyed 14,000 persons in the flames, besides a great number who were massacred in attempting to make their escape. The upper part of the city, however, was vigorously defended, so that the besiegers were at last obliged to abandon all thoughts of making themselves masters of it, and to content themselves with desolating the adjacent country. The next year Vitowda renewed his attempts upon this city, but with the same ill success; though he got possession of some places of less note. As soon, however, as an opportunity offered, he came to an accommodation with the king, who bestowed on him the government of Lithuania. During the first years of his government, he bestowed the most diligent attention upon domestic affairs, endeavouring to repair the calamities which the late wars had occasioned; but his impetuous valour prompted him at last to engage in a war with Tamerlane the Great, after his victory over Bajazet the Turkish emperor. For some time before, Vitowda had been at war with the neighbouring Tartars, and had been constantly victorious, transporting whole hordes of that barbarous people into Poland and Lithuania, where to this day they form a colony distinct in manners and dress from the other inhabitants. Uladislaus, however, dissuaded him from at-

tacking the whole strength of the nation under such a celebrated commander as Tamerlane: but Vitowda was obdurate; he encountered an army of 400,000 Tartars under Ediga, Tamerlane's lieutenant, with only a tenth part of their number. The battle continued for a whole day; but at last Vitowda was surrounded by the numbers of his enemy, and in the utmost danger of being cut in pieces. However, he broke his way through with prodigious slaughter on both sides; and came off at last without a total defeat, having killed a number of the enemy equal to the whole of his own army.

66
Wars with the Teutonic knights. During the absence of Vitowda, the Teutonic knights had penetrated into Lithuania, committing everywhere the most dreadful ravages. On his return he attacked and defeated them, making an irruption into Livonia, to punish the inhabitants of that country for the assistance they had given to the Teutonic order. This was succeeded by a long series of wars between Poland and Prussia, in which it became necessary for Uladislaus himself to take the field. The knights had now one way or other got possession of Samogitia, Mazovia, Culm, Silesia, and Pomerania; so that Uladislaus resolved to punish them before they became too powerful. With this view he assembled an army composed of several different nations, with which he penetrated into Prussia, took several towns, and was advancing to Marienburg the capital of Pomerania, when he was met by the army of the Prussian knights, who determined to hazard a battle. When the engagement began, the Poles were deserted by all their auxiliaries, and obliged to stand the brunt of the battle by themselves. But the courage and conduct of their king so animated them, that after a most desperate battle they obtained a complete victory; near 40,000 of the enemy being killed in the field, and 30,000 taken prisoners. This terrible overthrow, however, was less fatal to the affairs of the Prussian knights than might have been expected; as Uladislaus did not improve his victory, and a peace was concluded upon easier terms than his adversaries had any reason to expect.—Some infraction of the treaty occasioned a renewal of hostilities; and Uladislaus was so much elated with victory that he would hearken to no terms, by which means the enemy were driven to the desperate resolution of burying themselves in the ruins of their capital. The siege was accordingly commenced, and both sides behaved with the greatest vigour; but at last, through the good conduct and valour of the grand master of the knights named *Plawen*, the Polish monarch found himself obliged to grant them an advantageous peace, at a time when it was universally expected that the whole order would have been exterminated.

Uladislaus V. died in 1435, and was succeeded by his son Uladislaus VI. at that time only nine years of age. He had scarce ascended the throne, when the kingdom was invaded by the Tartars, who defeated Buccarius the general of the Polish forces; and committing everywhere dreadful ravages, returned to their own country loaded with booty. A few years after, the nation was involved in a war with Amurath the emperor of the Turks, who threatened to break into Hungary; and it was thought by the diet to be good policy to assist the Hungarians at this juncture, because it was impossible to know where the storm might

Poland. fall after Hungary was conquered. But before all things were prepared for the young king to take the field, a strong body of auxiliaries were dispatched under the celebrated John Hunniades vaivode of Transylvania, to oppose the Turks, and likewise to support the election of Uladislaus to the crown of Hungary. This detachment surprised the Turkish army near the river Morava, and defeated Amurath with the loss of 30,000 men; after which Hunniades retook all the places which had been conquered by Amurath, the proud sultan was forced to sue for peace, and Uladislaus was raised without opposition to the crown of Hungary. A treaty was concluded, by which the Turks promised to relinquish their designs upon Hungary, to acknowledge the king's right to that crown, and to give up all their conquests in Rascia and Servia. This treaty was sealed by mutual oaths: but Uladislaus broke it at the persuasion of the pope's legate; who insisted, that now was the time for humbling the power of the infidels; and produced a special commission from the pope, absolving him from the oath he had taken at the late treaty. The consequence of this perfidy was, that Uladislaus was entirely defeated and killed at Varna, and the greatest part of his army cut in pieces.

68
Uladislaus
defeated
and killed
by the
Turks.

69
Teutonic
knights
subdued.

Uladislaus VI. was succeeded by Casimir IV. in whose reign the Teutonic knights were subdued, and obliged to yield up the territories of Culm, Michlow, and the whole duchy of Pomerania, together with the towns of Elbing, Marienburg, Talmith, Schut, and Christburgh, to the crown of Poland. On the other hand, the king restored to them all the other conquests he had made in Prussia, granted a seat in the Polish senate to the grand-master, and endowed him with other privileges, on condition that, six months after his accession, he should do homage for Prussia, and take an oath of fidelity to the king and republic.

This success raised the spirits of the Polish nation, which had drooped ever since the battle of Varna. The diet did not, however, think proper to renew the war against the Turks, but took under their protection the hospodar of Moldavia; as thinking that this province would make a convenient barrier to the Polish dominions on one side. The request of the prince who asked this protection was therefore readily granted, an oath of fidelity exacted from him and the inhabitants, and a tribute required; regular payment of which was made for a great number of years afterwards.

70
Crowns of
Bohemia
and Hun-
gary united
to Poland.

About this time also the crown of Bohemia becoming vacant, the people were extremely desirous of being governed by one of the princes of Poland; upon which the barons were induced to bestow the crown upon Uladislaus, eldest son of Casimir, in opposition to the intrigues of the king of Hungary. Not satisfied with this acquisition, Uladislaus took advantage of the dissensions in Hungary, in order to unite that crown to his own: and this he also effected; by which means his power was greatly augmented, though not the felicity of his people. So many foreign expeditions had exhausted the treasury, and oppressed the peasants with taxes; the gentry were greatly diminished by a number of bloody engagements; agriculture was neglected, and the country almost depopulated. Before a proper remedy could be applied for these evils, Casimir died in 1492; much more admired, than beloved or regretted, by his subjects. It is

related by the historians of this period, that in the reign of Casimir IV. the deputies of the provinces first appeared at the diet, and assumed to themselves the legislative power; all laws before this time having been framed by the king in conjunction with the senate. It is observed also, that before Casimir's time, the Latin language was understood only by the clergy of Poland; in proof of which, it is alleged, that at an interview between this prince and the king of Sweden at Dantzick, his Polish majesty was forced to make use of the assistance of a monk to interpret between him and the Swedish monarch. Casimir, ashamed of the ignorance shown by himself and court, published an edict, enjoining the diligent study of the Latin, which in our days is spoken as vernacular by every Polish gentleman, though very unclassically.

During the succeeding reigns of John, Albert, and Alexander, the Polish affairs fell into decline; the kingdom being harassed by continual wars with the Turks and Tartars. However, they were retrieved by Sigismund I. who ascended the throne in 1507. This monarch, having reformed some internal abuses, next set about rendering the kingdom as formidable as it had formerly been. He first quelled a rebellion which broke out in Lithuania; after which, he drove the Walachians and Moldavians out of Russia Nigra, and defeated the Russians in a pitched battle, with the loss of 30,000 men. In this engagement he was obliged to cause his cavalry to swim across the Boristhenes in order to begin the attack, while a bridge was preparing for the infantry. These orders were executed with astonishing celerity, notwithstanding the rapidity of the stream, the steepness of the banks, and the enemy's opposition. The onset was led by the Lithuanians, who were directed to retreat gradually, with a view of drawing the enemy within reach of the cannon. This the Russians mistook for a real flight; and as they were pursuing with eagerness, Sigismund opened his line to the right and left, pouring in grape-shot from the artillery with dreadful success. The Russian general, and several noblemen of the first distinction, were taken prisoners, while the whole loss of the royal army did not amount to 300 men.

Poland.

71

Exploits of
Sigismund

After this complete victory, the king turned his arms against the Teutonic knights, who had elected the marquis of Brandenburg their grand-master; and this prince not only refused to acknowledge the sovereignty of the crown of Poland, but even invaded the Polish territories. Sigismund marched against him, and gained possession of several important places in Brandenburg; but as he was pursuing his conquests, the marquis was reinforced by 14,000 Germans, led by the duke of Schonenburg, who ventured to lay siege to Dantzic, after having ravaged all the neighbouring country. The Dantzickers, however, defended themselves with so much spirit, that the besiegers were soon obliged to relinquish their enterprise. In their retreat they were attacked by a strong detachment of Polish cavalry, who made prodigious havoc among them, and compelled the wretched remains to take shelter in Pomerania, where they were inhumanly butchered by the peasants. Soon after this the marquis was obliged to submit to the clemency of the conqueror; from whom, however, he obtained better conditions than could have been expected, or indeed than he would

Poland. would have got, had he not abandoned the interest of the Teutonic order, and resigned the dignity of grand-master. In order to secure him in his interest, therefore, Sigismund granted him half the province of Prussia as a secular duke, and dependent on the crown of Poland; by which means he entirely deprived that order of the best part of their dominions, and put it quite out of their power to disturb the tranquillity of Poland any more.

The power of Sigismund had now excited the jealousy of the House of Austria; for which reason they took every method in their power to stir up enemies against him. By their means, the Russians, Moldavians, and Tartars, were all excited to fall upon the Polish territories at once. The vaivode of Walachia, with 50,000 men, made an irruption into the small province of Pokation, but was entirely defeated by count Taro at the head of no more than 6000. This victory is wholly ascribed to the good conduct of the commander, who possessed himself of some eminences on the flanks of the enemy. On these he erected batteries; which played with such fury as soon put their ranks in disorder: upon which the Poles attacked them sword in hand, and entirely dispersed them with the loss of 10,000 killed or taken. The count having then augmented his army with a strong body of Lithuanians, attacked the Muscovites and Tartars, drove them entirely out of the duchy, pursued them into Russia, reduced several towns, and at last laid siege to the strong fortress of Stradub; in which the regent, together with some of the best troops of Russia, were inclosed. The garrison made a gallant defence; and the fortifications were composed of beams joined together, and supported by a bulwark of earth, upon which the cannon-shot made no impression: but the count contrived a method of setting the wood on fire; by which means the regent and nobility were obliged to surrender at discretion, and Taro carried off upwards of 60,000 prisoners, with an immense booty.

In the reign of Sigismund, we may look upon the kingdom of Poland to have been at its greatest pitch of glory. This monarch possessed, in his own person, the republic of Poland, the great duchies of Lithuania, Smolensko, and Saveria, besides vast territories lying beyond the Euxine and Baltic; while his nephew Lewis possessed the kingdoms of Bohemia, Hungary, and Silesia. But this glory received a sudden check in 1548, by the defeat and death of Louis, who perished in a battle fought with Solymán the Great, emperor of the Turks. The daughter of this prince married Ferdinand of Austria; whereby the dominions of Hungary, Bohemia, and Silesia, became inseparably connected with the hereditary dominions of the Austrian family. This misfortune is thought to have hastened the death of Sigismund; though, being then in his 84th year, he could not have lived long by the ordinary course of nature. He did not, however, survive the news many months, but died of a lingering disorder, leaving behind him the character of the completest general, the ablest politician, the best prince, and the strongest man, in the north; of which last, indeed, some instances are related by historians that are almost incredible.

Sigismund Augustus, who succeeded his father Sigismund I. proved also a very great and happy prince.

At that time the most violent and bloody wars were Poland. carrying on in Germany, and indeed through other parts of Europe, on account of religion; but Sigismund wisely avoided interfering in these disputes. He would not admit into his dominions any of those divines who were taxed with holding heterodox opinions, nor even allow his people the liberty of corresponding with them; yet he never persecuted, or employed any other means for the preservation of the state than those of a well-conducted and regular policy. Instead of disputing with his subjects about speculative opinions, Sigismund applied himself diligently to the reforming of abuses, enforcing the laws, enriching the treasury, promoting industry, and redeeming the crown-lands where the titles of the possessors appeared illegal. Out of the revenue recovered in this manner he obtained a formidable standing army, without laying any additional tax upon the subjects; and though he preferred peace to war, he was always able to punish those that offered indignities to his crown or person. His knowledge in the art of war was soon tried in a contest with the Russia. ⁷² ⁷³

Russians, who had made an irruption into Livonia, encouraged by the disputes which had subsisted between the Teutonic knights and the archbishop of Riga, cousin to Sigismund. The province was at that time divided between the knights and the prelate; and the Russians, under pretence of assisting the former, had seized great part of the dominions of the latter. The archbishop had recourse to his kinsman the king of Poland; who, after fruitless efforts to accommodate matters, marched towards the frontiers of Livonia with an army of 100,000 men. The knights were by no means able to resist such a formidable power; and therefore, deserting their late allies, put themselves under the protection of the king of Poland. The czar, John Basilides, though deserted by the knights, did not lose his courage; nay, he even insolently refused to return any answer to the proposals of peace made by Sigismund. His army consisted of 300,000 men, with whom he imagined himself able to reduce all Livonia, in spite of the utmost efforts of the king of Poland: however, having met with some checks on that quarter, he directly invaded Poland with his whole army. At first he carried every thing before him; but the Poles soon made a vigorous opposition. Yet the Russians, though everywhere defeated, still continued their incursions, which Sigismund at last revenged by invading Russia in his turn. These mutual desolations and ravages at last made both parties desirous of peace, and a truce for three years was agreed on; during the continuance of which the king of Poland died, and with him was extinguished the house of Jagellon, which had governed Poland for near 200 years. ⁷⁴

On the death of Sigismund, Poland became a prey to intestine divisions; and a vast number of intrigues were set on foot at the courts of Vienna, France, Saxony, Sweden, and Brandenburg; each endeavouring to establish a prince of their own nation on the throne of Poland. The consequence of all this was, that the kingdom became one universal scene of corruption, faction, and confusion; the members of the diet consulted only their own interest, and were ready on every occasion to sell themselves to the best bidder. The Protestants had by this time got a considerable footing in the kingdom, and thus religious disputes were intermingled. ⁷⁵

⁷² Sigismund Augustus, a wife and valiant prince.
⁷³ War with
⁷⁴ Extinction of the house of Jagellon.
⁷⁵ Distracted state of Poland.

Poland.

termingled with political ones. One good effect, however, flowed from this confusion : for a law was passed, by which it was enacted, that no difference in religious opinions should make any contention among the subjects of the kingdom ; and that all the Poles, without discrimination, should be capable of holding public offices and trusts under the government ; and it was also resolved, that the future kings should swear expressly to cultivate the internal tranquillity of the realm, and cherish without distinction their subjects of all persuasions.

While the candidates for the throne were severally attempting to support their own interest in the best manner they could, John Crasowski, a Polish gentleman of great merit, but diminutive stature, had just returned from France, whither he had travelled for improvement. His humour, wit, and diverting size, had rendered him universally agreeable at the court of France, and in a particular manner engaged the esteem of Catharine de Medicis, which the little Pole had the address to make use of for his own advantage. He owed many obligations to the duke of Anjou ; whom, out of gratitude, he represented in such favourable terms, that the Poles began to entertain thoughts of making him their king. These sentiments were confirmed and encouraged by Crasowski, who returned into France by order of several leading men in Poland, and acquainted the king and queen Catharine, that nothing was wanting besides the formality of an embassy to procure the crown for the duke of Anjou, almost without opposition. Charles IX. king of France, at that time also promoted the scheme, being jealous of the duke of Anjou's popularity, and willing to have him removed to as great a distance as possible. Accordingly the parties came to an agreement ; and it was stipulated that the duke of Anjou should maintain the laws, liberties, and customs of the kingdom of Poland, and of the grand duchy of Lithuania ; that he should transport all his effects and annual revenues in France into Poland ; that the French monarch should pay the late king Sigismund's debts ; that he should maintain 100 young Polish gentlemen at his court ; and 50 in other places ; that he should send a fleet to the Baltic, to assist Poland against the Russians ; and lastly, that Henry should marry the princess Anne, sister to the late king Sigismund ; but this article Henry would not ratify till his return to Poland.

Every thing being thus settled, the young king quitted France, attended by a splendid retinue, and was accompanied by the queen-mother as far as Lorraine. He was received by his subjects on the frontiers of Poland, and conducted to Cracow, where he was soon after crowned. The affections of the Poles were soon engaged by the youth and accomplishments of Henry ; but scarce was he seated on the throne, when, by the death of Charles IX. he became heir to the crown of France. Of this he was informed by repeated messages from queen Catharine ; he repented his having accepted the crown of Poland, and resolved to leave it for that of France. But being sensible that the Poles would oppose his departure, he kept his intentions secret, and watched an opportunity of stealing out of the palace in disguise in the night-time. The Poles, as might well have been expected, were irritated at being thus abandoned, from the mere motive of interest, by

a prince whom they had loved and honoured so much. Parties were dispatched after him by different roads ; and Zamoski, a nobleman who headed one of these parties, overtook him some leagues distant from Cracow. All the prayers and tears of that nobleman, however, could not prevail on Henry to return ; he rode post to Vienna, and then passed into France by the way of Italy.

In the mean time, the Poles were so much exasperated against Henry and his whole nation, that all the French in Cracow would have been massacred if the magistrates had not placed guards in the streets. Henry, however, had foreseen the consequences of his flight, and therefore endeavoured to apologise for his behaviour. One Danzai undertook his cause in full senate ; and with great eloquence explained the king's motives for his abrupt departure. Henry also wrote to the chief nobility and clergy with his own hand. But nothing could satisfy the Poles ; who now acquainted their king, that if he did not immediately return, they would be obliged to divest him of the royal dignity, and to choose another sovereign. Henry began to excuse himself on account of the wars in which he was engaged, and promised to send men of unexceptionable integrity to govern Poland till he should return : but no excuses could be accepted ; and, on the 15th of July, 1575, he was solemnly divested of the regal dignity in full diet, and the throne declared vacant.

After the deposition of Henry, commotions and factions again took place. However, the contending parties were now reduced to two ; one who supported the interest of Maximilian emperor of Germany ; the other, who were for electing the princess Anne, and marrying her to Stephen Batori prince of Transylvania. The latter prevailed through the courage of one gentleman, who, in imitation of the power assumed by the Roman tribunes, stood up in the full senate, and opposed the proclamation of Maximilian, declaring that his election was violent and illegal. In this situation of affairs, it was obvious that strength and celebrity must determine which election was legitimate : both parties wrote to the princes whose cause they had espoused, intreating them to come with all possible expedition to take possession of the throne. Batori proved the more alert ; for while Maximilian was disputing about certain conditions which the Poles required for the security of their privileges, he entered Poland, married the princess, and was crowned on the first of May 1576.

No opposition was made to the authority of Batori except by the inhabitants of Dantzic. These adhered to the interest of Maximilian even after he was dead, and had the presumption to demand from the king an oath acknowledging their absolute freedom and independence. Batori referred them to the senate, declaring that he had no right to give up the privileges of the republic ; but admonished the citizens to avoid all occasion of a civil war, which must necessarily terminate in their disadvantage. But the obstinate citizens, construing the king's lenity into fear, shut the gates against the ambassador, seized upon the fortrefs of Grebin, and published a manifesto resembling a libel upon the king and the republic. The king, incensed at these proceedings, marched against Grebin, retook the castle, and ravaged certain territories belonging

Poland.

78
And is deposed.79
Stephen Batori chosen king.80
Dantzic revolts.76
Duke of Anjou chosen king of Poland.77
Runs away from his kingdom.

Poland. longing to the Dantzickers; who retaliated by burning to the ground a monastery named *Oliva*, to prevent the Poles from taking possession of so important a situation.

81
oland in-
aded by
re Ruf-
ans.

82
Dantzic
ubmits.

83
Cruelty of
the Ruf-
sians.

Notwithstanding these outrages, Batori renewed his overtures for an accommodation: but the Dantzickers were deaf to these salutary proposals; so that he was obliged to declare them rebels, and send against them a body of troops under one Zborowski. As the number of the Polish army, however, was not considerable, the Dantzickers marched out to give him battle. They were assisted by a corps of Germans, and a resolution was formed of attacking the Poles in their camp by surprise; but the project was disconcerted by a sudden storm, accompanied with dreadful thunder and lightning, which spread a panic through the army, as if it had been a judgment from heaven, and obliged the commander, John de Collen, to retire into the city. In a short time, however, they recovered their spirits, and came to an action with the Poles; but were defeated with the loss of 8000 men killed on the spot, a great many taken prisoners, and the loss of several pieces of cannon. But this check, instead of abating the courage of the Dantzickers, only animated them the more, and they resolved to hold out to the last extremity. In the mean time, the czar of Muscovy, thinking the present opportunity favourable for extending his dominions, laid siege to Revel; but, not being able to make himself master of that place, he was obliged to content himself with ravaging Livonia, which he did in a dreadful manner. This did not, however, hinder Batori from laying siege to Dantzic in person, and pursuing the operations with the utmost vigour. Collen made many vigorous sallies, in several of which he defeated the Poles; but happening at last to be killed, nobody was found capable of supplying his place, and the citizens were at last obliged to surrender at discretion; though not till they had obtained a promise from the elector of Saxony and landgrave of Hesse of interposing as mediators in their behalf. The only terms which the king demanded of them were, that they should ask his pardon, dismiss their troops, and rebuild the monastery of *Oliva* which they had destroyed; while his majesty, on the other hand, confirmed all their privileges, and granted them full liberty of adhering to the confession of Augsburg, for which they had for some time been strenuous advocates.

The war with Dantzic was no sooner ended, than the king directed his whole strength against the czar of Muscovy, who had made himself master of several important cities in Livonia. The czar behaved every where with the greatest cruelty, slaughtering all without distinction who were able to bear arms, and abandoning the women and children to the shocking brutality of the Tartars who served in his army. Such was the horror inspired by the perfidy and cruelty of the czar's conduct, that the inhabitants of Wender chose rather to bury themselves in the ruins of their town than to submit to such an inhuman enemy. For a considerable time the Russians were allowed to proceed in this manner, till the whole province of Livonia, excepting Riga and Revel, had suffered the barbarities of this insulting conqueror; but at last, in 1578, a body of forces was dispatched into the province, the towns of Wender and

Dunnenburg were surprised, and an army sent by the **Poland.** czar to surprise the former was defeated.

At this time the Muscovites were not the only enemies who opposed the king of Poland, and oppressed Livonia. That unhappy province was also invaded by the Swedes, who professed themselves to be enemies equally to both parties, and who were scarce inferior in cruelty to the Russians themselves. The king, however, was not daunted by the number of his adversaries; but having made great preparations, and called to his assistance Christopher prince of Transylvania, with all the standing forces of that country, he took the field in person against the Muscovites, and laid siege to Polocz, a town of great importance situated on the river Dwina. The Russians no sooner heard of the approach of the Polish army, than they resolved to put all the citizens to death, thinking by this means to strike terror into the enemy. When Batori came near the town, the most shocking spectacle presented itself; the river appeared dyed with blood, and a vast number of human bodies fastened to planks, and terribly mangled, were carried down its stream. This barbarity, instead of intimidating the Poles, irritated them to such a degree, that nothing could resist them. Finding that their cannon made little impression upon the walls of the city, which were constructed of wood, they advanced to the assault with burning torches in their hands; and would soon have reduced the fortifications to ashes, had not a violent storm of rain prevented them. The design, however, was put in execution as soon as the rain slackened; and the barbarous Russians were obliged to surrender at discretion. It reflects the highest honour on Batori, that, notwithstanding the dreadful instances of cruelty which he had before his eyes, he would not suffer his soldiers to retaliate. Indeed the cruelties committed by the Russians on this occasion, seem almost to have authorised any revenge that could possibly have been taken. A number of Germans were found in the city, some expiring under the most dreadful tortures, and others dead of pains which nature could no longer support. Several of the officers had been dipped in cauldrons of boiling oil, with a cord drawn under the skin of the umbilical region, which fastened their hands behind; in which situation their eyes had been torn out from their sockets, or burnt with red-hot irons, and their faces otherwise terribly mangled. The disfigured carcases, indeed, plainly showed the barbarous treatment they had met with; and the dreadful tale was confirmed by the testimony of the few who survived. The Polish soldiers were exasperated almost to madness; so that scarce all the authority of Batori could restrain them from cutting in pieces the wretches who had been the authors of such a dreadful tragedy.

84
Siege of
Polocz.

85
Monstrous
barbarities
committed
by the Rus-
sians in
that city.

After the reduction of Polocz, Batori continued the war with great success. Two detachments from the army penetrated the enemy's country by different roads, wasted all before them to the gates of Smolensko, and returned with the spoils of 2000 villages which they had pillaged and destroyed. In the mean time the Swedes and Poles thought proper to come to an accommodation: and though John king of Sweden was at that time prevented from bearing his share of the war, yet Batori reduced such a number of cities, and committed such

86
Russia rav-
aged by Ba-
tori.

Poland. 87
The Czar
sues for
peace.

such devastations in the Russian territories, that the czar was obliged to sue for peace; which he obtained on condition of relinquishing Livonia, after having thrown away the lives of more than 400,000 of his subjects in attempting to conquer it.

Poland. 90
War with
Gustavus
Adolphus.

prince was soon after deposed; and the Russians not only regained their liberty, but began to make encroachments on Poland itself. A very unfortunate war also took place with Sweden, which was now governed by the great Gustavus Adolphus; the particulars of which, with the other exploits of that renowned warrior, are related under the article SWEDEN. At last Sigismund, worn out with cares and misfortunes, died in 1629.

After Sigismund's death the affairs of Poland seemed to revive a little under Uladislaus VII.; for he obliged the Russians to sue for peace, and Sweden to restore some of her conquests: but having attempted to abridge the liberty of the Cossacks, they revolted, and gave the Poles several terrible defeats. Nor was the war terminated in the lifetime of Uladislaus, who died in 1648. His successor, John Casimir, concluded a peace with these dangerous enemies: but the war was soon after renewed; and while the kingdom was distracted between these enemies and the discontents of its own inhabitants, the Russians took the opportunity of invading and pillaging Lithuania. In a little after the whole kingdom was subdued by Charles Gustavus, successor to Christina queen of Sweden.

Happily for Poland, however, a rupture took place between the courts of Sweden and Copenhagen; by which means the Poles were enabled to drive out the Swedes in 1657. This was succeeded by civil wars and contests with Russia, which so much vexed the king, that he resigned the crown in 1668.

For two years after the resignation of Casimir the kingdom was filled with confusion; but on the 17th of September 1670, one Michael Coribut Wiefnowiski, collaterally descended from the house of Jagello, but in a very mean situation at that time, was chosen king. His reign continued but for three years; during which time John Sobieski, a celebrated Polish general, gave the Turks a dreadful overthrow, though their army consisted of more than 300,000 men; and had this blow been pursued, the Cossacks would have been entirely subdued, and very advantageous terms might have been obtained from the sultan. Of that vast multitude of Turks no more than 15,000 made their escape, the rest being all either killed or taken: however, the Polish foldiers, being bound by the laws of their country only to stay a certain time in the field, they refused to pursue this signal victory, and suffered the king to make peace on any terms he could procure.

Wiefnowiski died before the news of this transaction reached Cracow; and after his death a new scene of confusion ensued, till at last the fortune of John Sobieski prevailed, and he was elected king of Poland in 1674. He was a most magnanimous and heroic prince; who, by his valour and good conduct, retrieved the affairs of Poland, and entirely checked the progress of the Turks westward. These barbarians were everywhere defeated, as is particularly related under the article TURKEY; but notwithstanding his great qualities, Poland was now so thoroughly corrupted, and pervaded by a spirit of dissipation, that the latter part of this monarch's reign was involved in troubles, through the ambition and contention of some powerful noblemen.

Sobieski died in 1696; and with him fell the glory of Poland. Most violent contests took place about the succession; the recital of which would far exceed our limits.

88
Batori civilizes the
Cossacks.

Batori, being thus freed from a most destructive and cruel war, applied himself to the internal government of his kingdom. He regulated the Polish cavalry in such a manner as made them become formidable to the Turks and other neighbouring nations: and this is the military establishment to which the Poles have given the name of *quartienne*; because a fourth part of the revenue is employed in supporting them. Batori sent this body of cavalry towards the frontiers of Tartary, to check the incursions of those barbarians; by which means the Ukraine, a vast tract of desert country, was filled with flourishing towns and villages, and became a strong barrier against the Turks, Tartars, and Russians. The last memorable action of Batori was his attaching the Cossacks to Poland, civilizing and instructing them in the arts of war and peace. His first endeavour was to gain their affections by his liberality; for which purpose, he presented them with the city of Techtemeravia, situated on the Boristhenes, which they formed into a magazine, and made the residence of their chieftains. He gave them officers of all degrees, established discipline among them, altered their arms, and formed them into a regular militia, which afterwards performed eminent services to the state. All kinds of manufactures at that time known in Poland were likewise established among the Cossacks; the women were employed in spinning and weaving woollen cloths, while the men were taught agriculture, and other arts proper for their sex.

While Batori was employed in this manner, the Swedes broke the convention into which they had entered with Poland, and were on the point of getting possession of Riga. To this, indeed, Batori himself had given occasion, by attempting to impose the Romish religion upon the inhabitants, after having promised them entire liberty of conscience. This so irritated them, that they revolted, and were on the point of admitting a Swedish garrison into the city, when the king was informed of what was going forward. Upon this he resolved to take a most exemplary vengeance on the inhabitants of Riga; but before he could execute his intention, he died in the year 1586, the 54th of his age, and 10th of his reign.

89
His death.

The death of Batori involved Poland in fresh troubles. Four candidates appeared for the crown, viz. the princes Ernest and Maximilian of the house of Austria; Sigismund prince of Sweden, and Theodore czar of Muscovy. Each of these had a separate party; but Sigismund and Maximilian managed matters so well, that in 1587 both of them were elected. The consequence of this was a civil war; in which Maximilian was defeated and taken prisoner: and thus Sigismund III. surnamed *De Vasa*, became master of the throne of Poland without opposition. He waged a successful war with the Tartars, and was otherwise prosperous; but though he succeeded to the crown of Sweden, he found it impossible for him to retain both kingdoms, and he was formally deposed from the Swedish throne. In 1610 he conquered Russia, and placed his son on the throne; but the Polish conquests of that country have always been but for a short time. Accordingly the young

92
John So-
bieski re-
trieves the
Polish af-
fairs.

Poland.

limits. At last Frederic Augustus, elector of Saxony, prevailed; but yet, as some of the most essential ceremonies were wanting in his coronation, because the primate, who was in an opposite interest, would not perform them, he found it extremely difficult to keep his subjects in proper obedience. To add to his misfortunes, having engaged in a league with Denmark and Russia against Sweden, he was attacked with irresistible fury by Charles XII. Though Augustus had not been betrayed, as indeed he almost always was, he was by no means a match for the ferocious Swede. The particulars of this war, however, as they make great part of the exploits of that northern hero, more properly fall to be related under the article SWEDEN. Here, therefore, we shall only observe, that Augustus was reduced to the humiliating necessity of renouncing the crown of Poland on oath, and even of congratulating his rival Stanislaus upon his accession to the throne: but when the power of Charles was broken by his defeat at Pultowa, the fortune of Augustus again prevailed; Stanislaus was driven out; and the former being absolved from his oath by the pope, resumed the throne of Poland.

93
Poland
conquered
by Charles
XII.

94
Degeneracy
of the
Poles.

Since that time the Polish nation hath never made any figure. Surrounded by great and ambitious powers, it hath sunk under the degeneracy of its inhabitants; so that it now scarce exists as a nation. This catastrophe took place in the following manner: On the 5th of October 1763, died Augustus III. elector of Saxony, and king of Poland. He was succeeded by Count Poniatowski, a Polish grandee, who was proclaimed September 7th 1764, by the name of *Stanislaus Augustus*, and crowned on the 25th of November the same year.—During the interregnum which took place between the death of Augustus III. and the election of Stanislaus, a decree had been made by the convocation-diet of Poland, with regard to the *dissidents*, as they were called, or dissenters from the Popish religion. By this decree they were prohibited from the free exercise of their religion, much more than they had formerly been, and totally excluded from all posts and places under the government. On this several of the European powers interposed, at the application of the dissidents, for their good offices. The courts of Russia, Prussia, Great Britain, and Denmark, made remonstrances to the diet; but, notwithstanding these remonstrances, the decree was confirmed by the coronation-diet held after the king's election.

96
Interference of foreign
powers in
behalf of
the dissidents.

October 6. 1766, an ordinary diet was assembled. Here declarations from the courts above mentioned were presented to his Polish majesty, requiring the re-establishment of the dissidents in their civil rights and privileges, and the peaceable enjoyment of their modes of worship secured to them by the laws of the kingdom which had been observed for two centuries. These privileges, it was alleged, had been confirmed by the treaty of Oliva, concluded by all the northern powers, which could not be altered but by the consent of all the contracting parties. The Popish party contended strongly for a confirmation of some decrees made against the dissidents in 1717, 1723, and 1736. The deputies from the foreign powers replied, that those decrees had passed in the midst of intestine troubles, and were contradicted by the formal protestations and express decla-

Vol. XV. Part I.

rations of foreign powers. At last, after violent contests, the matter was referred to the bishops and senators for their opinion. Upon a report from them, the diet came to a resolution, That they would fully maintain the dissidents in all the rights and prerogatives to which they were intitled by the laws of their country, particularly by the constitutions of the year 1717, &c. and by treaties; and that as to their complaints with regard to the exercise of their religion, the college of archbishops and bishops, under the direction of the prince primate, would endeavour to remove those difficulties in a manner conformable to justice and neighbourly love.—By this time, however, the court of Russia seemed determined to make her remonstrances more effectual, and a small body of Russian troops marched to within two miles of the capital of Poland.

These resolutions of the diet were by no means agreeable to the dissidents. They dated the beginning of their sufferings from the year 1717. The referring their grievances to the archbishops and bishops was looked upon as a measure the most unreasonable that could be imagined, as that body of men had always been their opposers, and in fact the authors of all the evils which had befallen them.—Shortly after matters were considered in this view, an additional body of Russians, to the number of about 15,000, entered Poland.

The dissidents, being now pretty sure of the protection of foreign powers, entered, on the 20th of March 1767, into two confederacies, at Thorn and Sluck. One of them was signed by the dissidents of Great and Little Poland, and the other by those of the Great Duchy of Lithuania. The purport of these confederacies was, an engagement to exert themselves in the defence of their ancient privileges, and the free exercise of their religion; professing, at the same time, however, the utmost loyalty to the king, and resolving to send a deputation to him to implore his protection. They even invited those of the Catholic communion, and all true patriots, to unite with them in maintaining the fundamental laws of the kingdom, the peace of religion, and the right of each one jointly with themselves. They claimed, by virtue of public treaties, the protection of the powers who were guaranties of their rights and liberties; namely, the emperors of Russia, and the kings of Sweden, Great Britain, Denmark, and Prussia. Lastly, they protested, that they had no intention of acting to the detriment of the Roman Catholic religion, which they duly respected; and only asked the liberty of their own, and the re-establishment of their ancient rights. The three cities of Thorn, Elbing, and Dantzic, acceded to the confederacy of Thorn on the 10th of April; as did the duke and nobles of Courland to that of Sluck on the 15th of May.

The emperors of Russia and king of Prussia, in the mean time, continued to issue forth new declarations in favour of the dissidents; and the Russian troops in Poland were gradually augmented to 30,000 men. Great numbers of other confederacies were also formed in different parts of the kingdom. These at first took little part in the affairs of the dissidents: they complained only of the administration of public affairs, into which they alleged that innovations had been introduced, and were therefore for some time called *confederations of malcontents*. All these confederacies published manifestoes,

Poland.

97
Consequences
of this.

O o in

Poland

98
General
confederacy.

in which they recommended to the inhabitants to quarter and treat the Russian troops as the defenders of the Polish liberties.

The different confederacies of malcontents formed in the 24 districts of Lithuania united at Wilna on the 22d of June; and that general confederacy re-established prince Radzivil, who had married the king's sister, in his liberty, estates, and honour, of which he had been deprived in 1764 by the states of that duchy. On the 23d of June prince Radzivil was chosen grand marshal of the general confederacy of all Poland, which then began to be called the *national confederacy*, and was said to be composed of 72,000 noblemen and gentlemen.

The general confederacy took such measures as appeared most proper for strengthening their party. They sent to the several waywodes of the kingdom, requiring their compliance with the following articles: 1. That all the gentlemen who had not signed the confederacy should do it immediately; 2. That all the courts of justice should subsist as formerly, but not judge any of the confederates; 3. That the marshals of the crown should not pass any sentence without the participation of at least four of the confederates; and, 4. That the marshals of the crown and the treasurers should be immediately restored to the possession of their respective rights. The Catholic party in the mean time were not idle. The bishop of Cracow sent a very pathetic and zealous letter to the dietines assembled at Warsaw on the 15th of August, in which he exhorted them to arm their nuncios with courage, by giving them orthodox and patriotic instructions, that they might not grant the dissidents new advantages beyond those which were secured to them by the constitutions of the country, and treaties with foreign powers, &c. The pope also sent briefs to the king, the great chancellor, the noblesse, bishops of the kingdom, and to the prince primate, with such arguments and exhortations as were thought most proper to ward off the impending danger. Councils in the mean time were frequently held at the bishop of Cracow's palace, where all the prelates at Warsaw assembled.

On the 26th of September 1767 the confederacy of dissidents was united with the general confederacy of malcontents in the palace of prince Radzivil, who on that occasion expressed great friendship for the dissidents. In a few days after, the Russian troops in the capital were reinforced, and a considerable body of them was posted at about five miles distance.

99
Tumults
in the diet.

On the 5th of October an extraordinary diet was held: but the affair of the dissidents met with such opposition, that it was thought necessary to adjourn the meeting till the 12th; during which interval, every expedient was used to gain over those who opposed prince Radzivil's plan. This was, to appoint a commission, furnished with full power to enter into conference with prince Repnin, the Russian ambassador, concerning the affairs of the dissidents. Notwithstanding all the pains taken, however, the meeting of the 12th proved exceedingly tumultuous. The bishops of Cracow and Kiow, with some other prelates, and several magnats, declared, that they would never consent to the establishment of such a commission; and at the same time spoke with more vehemence than ever against the pretensions of the dissidents. Some of the deputies answered with great warmth; which occasioned such ani-

mosities, that the meeting was again adjourned till the 16th.

On the 13th the bishops of Cracow and Kiow, the palatine of Cracow, and the staroste of Dolmski, were carried off by Russian detachments. The crime alleged of the prince Repnin, was, that they had been wanting in respect to the dignity of the empress of Russia, by attacking the purity of her intentions towards the republic; though she was resolved to continue her protection and assistance to the general confederacy united for preserving the liberties of Poland, and correcting all the abuses which had been introduced into the government, &c.

It was probably owing to this violent proceeding of the Russians, that prince Radzivil's plan was at last adopted, and several new regulations were made in favour of the dissidents. These innovations, however, soon produced a civil war, which at last ended in the ruin of the kingdom. In the beginning of the year 1768, a new confederacy was formed in Podolia, a province bordering on Turkey, which was afterwards called the *confederacy of Bar*. The intention of it was, to abolish, by force of arms, the new constitutions, particularly those in favour of the dissidents. The members of the new confederacy likewise expressed great resentment against the carrying away the bishops of Cracow, &c. and still detaining them in custody.

Podolia was reckoned the fittest place for the purpose of the confederates, as they imagined the Russians could not attack them there without giving umbrage to the Ottoman court. Similar confederacies, however, were quickly entered into throughout the kingdom: the clergy excited all ranks of men to exert themselves in defence of their religion; and so much were their exhortations regarded, that even the king's troops could not be trusted to act against these confederates. The empress of Russia threatened the new confederates as disturbers of the public tranquillity, and declared that her troops would act against them if they persisted. It was, however, some time before the Russian troops were considerably reinforced; nor did they at first seem inclined to act with the vigour which they might have exerted. A good many skirmishes soon happened between these two contending parties, in which the confederates were generally defeated. In one of these the latter being worsted, and hardly pressed, a number of them passed the Niester, and took refuge in Moldavia. This province had formerly belonged to Poland, but was now subject to the Grand Signior: the Russians, however, pursued their enemies into Moldavia; but in order to prevent any offence being taken by the Porte, prince Repnin wrote to the Russian resident at Constantinople, to intimate there, that the conduct of the Russian colonel who commanded the party was quite contrary to the orders of his court, and that therefore he would be turned out of his post.

Great cruelty in the mean time was exercised against the dissidents where there were no Russian troops to protect them. Towards the end of October 1769, prince Martin Lubomirski, one of the southern confederates, who had been driven out of Poland, and had taken shelter with some of his adherents among the mountains of Hungary, got a manifesto posted up on several of the churches of Cracow, in which he invited

the

¹⁰² Poland. the nation to a general revolt, and assuring them of the assistance of the Ottoman Porte, with whom he pretended to have concluded a treaty. This was the beginning of hostilities between the Turks and Russians, which were not terminated but by a vast effusion of blood on both sides.

¹⁰² War between this confederacy and the Russians.

The unhappy kingdom of Poland was the first scene of this war, and in a short time was reduced to the most deplorable situation. In the end of the year 1768, the peasants of the Greek religion in the Polish Ukraine, and province of Kiow, took up arms, and committed the greatest ravages, having, as they pretended, been threatened with death by the confederates unless they would turn Roman Catholics. Against these insurgents the Russians employed their arms, and made great numbers of them prisoners. The rest took refuge among the Haidamacks; by whom they were soon joined, and in the beginning of 1769 entered the Ukraine in conjunction with them, committing everywhere the most horrid massacres. Here, however, they were at last defeated by the Polish troops, at the same time that several of the confederacies in Poland were severely chastised. Soon after, the Clan of the Crim Tartars, having been repulsed with loss in an attempt on New Servia, entered the Polish territories, where he left frightful marks of his inhumanity upon some innocent and defenceless persons. This latter piece of conduct, with the cruelties exercised by the confederates, induced the Polish Cossacks of Braclau and Kiowia, amounting to near 30,000 effective men, to join the Russians, in order to defend their country against these destroyers. Matters continued much in the same way during the rest of the year 1769; and in 1770, skirmishes frequently happened between the Russians and confederates, in which the latter were almost always worsted; but they took care to revenge themselves by the most barbarous cruelties on the dissidents, wherever they could find them. In 1770, a considerable number of the confederates of Bar, who had joined the Turks, and been excessively ill used by them, came to an accommodation with the Russians, who took them under their protection on very moderate terms.—Agriculture in the mean time had been so much neglected, that the crop of 1770 was very deficient. This encouraged a number of desperadoes to associate under the denomination of *confederates*, who were guilty of still greater excesses than those who had been under some kind of regulation. Thus a great part of the country was at last reduced to a mere desert, the inhabitants being either exterminated, or carried off to stock the remote Russian plantations, from whence they never could return.

¹⁰³ New confederacies.

In the year 1771, the confederacies, which seemed to have been extinguished, sprung up afresh, and increased to a prodigious degree. This was occasioned by their having been secretly encouraged and supplied with money by France. A great number of French officers engaged as volunteers in their service; who, having introduced discipline among their troops, they acted with much greater vigour than formerly, and sometimes proved too hard for their enemies. These gleams of success proved at last their total ruin. The Russians were reinforced, and properly supported. The Austrian and Prussian troops entered the country, and advanced on different other sides; and the confederates

found themselves in a short time entirely surrounded by their enemies, who seemed to have nothing less in view than an absolute conquest of the country, and sharing it among themselves.

¹⁰⁴ Attempt to assassinate the king.

Before matters came to this crisis, however, the confederates formed a design of assassinating the king, on account of his supposed attachment to the dissidents. Of this singular occurrence we have the following account in the travels of Mr Coxe, communicated to the author by Mr Wrasall.—“A Polish nobleman, named *Pulaski*, a general in the army of the confederates, was the person who planned the atrocious enterprise; and the conspirators who carried it into execution were about 40 in number, and were headed by three chiefs, named *Lukawski*, *Strawinski*, and *Kosinski*. These three chiefs had been engaged and hired to that purpose by Pulaski, who in the town of Czetshokow in Great Poland obliged them to swear in the most solemn manner, by placing their hands between his, either to deliver the king alive into his hands, or, in case that was impossible, to put him to death. The three chiefs chose 37 persons to accompany them. On the second of November, about a month after they had quitted Czetshokow, they obtained admission into Warsaw, unsuspected or undiscovered, by the following stratagem. They disguised themselves as peasants who came to sell hay, and artfully concealed their saddles, arms, and clothes, under the loads of hay which they brought in waggons, the more effectually to escape detection.

“On Sunday night, the third of September 1771, a few of these conspirators remained in the skirts of the town; and the others repaired to the place of rendezvous, the street of the Capuchins, where his majesty was expected to pass by about his usual hour of returning to the palace. The king had been to visit his uncle prince Czartoriski, grand chancellor of Lithuania, and was on his return from thence to the palace between nine and ten o'clock. He was in a coach, accompanied by at least 15 or 16 attendants, beside an aid-de-camp in the carriage: scarce was he at the distance of 200 paces from prince Czartoriski's palace, when he was attacked by the conspirators, who commanded the coachman to stop on pain of instant death. They fired several shot into the carriage, one of which passed through the body of a heyduc, who endeavoured to defend his master from the violence of the assassins. Almost all the other persons who preceded and accompanied his majesty were dispersed; the aid-de-camp abandoned him, and attempted to conceal himself by flight. Meanwhile the king had opened the door of his carriage with the design of effecting his escape under shelter of the night, which was extremely dark. He had even alighted, when the assassins seized him by the hair, exclaiming in Polish, with horrible execrations, ‘We have thee now; thy hour is come.’ One of them discharged a pistol at him so very near, that he felt the heat of the flash; while another cut him across the head with his sabre, which penetrated to the bone. They then laid hold of his majesty by the collar, and, mounting on horseback, dragged him along the ground between their horses at full gallop for near 500 paces through the streets of Warsaw.

¹⁰⁵ Who is taken prisoner.

¹⁰⁶ And wounded.

“Soon finding, however, that he was incapable of following them on foot, and that he had already almost

Poland.

lost his respiration from the violence with which they had dragged him, they set him on horseback; and then redoubled their speed for fear of being overtaken. When they came to the ditch which surrounds Warsaw, they obliged him to leap his horse over. In the attempt the horse fell twice, and at the second fall broke its leg. They then mounted his majesty upon another, all covered as he was with dirt.

107
And rifled.

"The conspirators had no sooner crossed the ditch, than they began to rifle the king, tearing off the order of the Black Eagle of Prussia which he wore round his neck, and the diamond cross hanging to it. He requested them to leave his handkerchief, which they consented to: his tablets escaped their rapacity. A great number of the assassins retired after having thus plundered him, probably with intent to notify to their respective leaders the success of their enterprise; and the king's arrival as a prisoner. Only seven remained with him, of whom Kosiński was the chief. The night was exceedingly dark; they were absolutely ignorant of the way; and, as the horses could not keep their legs, they obliged his majesty to follow them on foot, with only one shoe, the other being lost in the dirt.

108
His presence of mind remarkable.

"They continued to wander through the open meadows, without following any certain path, and without getting to any distance from Warsaw. They again mounted the king on horseback, two of them holding him on each side by the hand, and a third leading his horse by the bridle. In this manner they were proceeding, when his majesty, finding they had taken the road which led to a village called *Burakowo*, warned them not to enter it, because there were some Russians stationed in that place who might probably attempt to rescue him (A). Finding himself, however, incapable of accompanying the assassins in the painful posture in which they held him kept down on the saddle, he requested them, since they were determined to oblige him to proceed, at least to give him another horse and a boot. This request they complied with; and continuing their progress through almost impassable lands, without any road, and ignorant of their way, they at length found themselves in the wood of Bielany, only a league distant from Warsaw. From the time they had passed the ditch they repeatedly demanded of Kosiński their chief, if it was not yet time to put the king to death; and these demands were reiterated in proportion to the obstacles and difficulties they encountered, till they were suddenly alarmed by a Russian patrol or detachment. Instantly holding council, four of them disappeared, leaving him with the other three, who compelled him to walk on. Scarce a quarter of an hour after, a second Russian guard challenged them anew. Two of the assassins then fled, and the king remained alone with Kosiński the chief, both on foot. His majesty, exhausted with all the fatigue which he had undergone, implored his conductor to stop, and suffer him to take a moment's repose. Kosiński refused it, menacing him with his naked sabre; and at the

same time informed him, that beyond the wood they should find a carriage. They continued their walk, till they came to the door of the convent of Bielany. Kosiński appeared lost in thought, and so much agitated by his reflections, that the king perceiving his disorder, and observing that he wandered without knowing the road, said to him, 'I see you are at loss which way to proceed. Let me enter the convent of Bielany, and do you provide for your own safety.' 'No (replied Kosiński), I have sworn.'

Poland.

"They proceeded till they came to Mariemont, a small palace belonging to the house of Saxony, not above half a league from Warsaw: here Kosiński betrayed some satisfaction at finding where he was, and the king still demanding an instant's repose, he consented at length. They sat down together on the ground, and the king employed these moments in endeavouring to soften his conductor, and induce him to favour or permit his escape. His majesty represented the atrocity of the crime he had committed in attempting to murder his sovereign, and the invalidity of an oath taken to perpetrate so heinous an action: Kosiński lent attention to this discourse, and began to betray some marks of remorse. But (said he), if I should consent and reconduct you to Warsaw, what will be the consequence? I shall be taken and executed! I give you my word (answered his majesty), that you shall suffer no harm; but if you doubt my promise, escape while there is yet time. I can find my way to some place of security; and I will certainly direct your pursuers to take the contrary road to that which you have chosen. Kosiński could not any longer contain himself, but, throwing himself at the king's feet, implored forgiveness for the crime he had committed; and swore to protect him against every enemy, relying totally on his generosity for pardon and preservation. His majesty reiterated to him his assurances of safety. Judging, however, that it was prudent to gain some asylum without delay, and recollecting that there was a mill at some considerable distance, he immediately made towards it. Kosiński knocked, but in vain; no answer was given: he then broke a pane of glass in the window, and intreated for shelter to a nobleman who had been plundered by robbers. The miller refused, supposing them to be banditti, and continued for more than half an hour to persist in his denial. At length the king approached, and speaking through the broken pane, endeavoured to persuade him to admit them under his roof, adding, 'If we were robbers, as you suppose, it would be very easy for us to break the whole window, instead of one pane of glass.' This argument prevailed. They at length opened the door, and admitted his majesty. He immediately wrote a note to General Coccei, colonel of the foot-guards, informing him of his danger and miraculous escape.

"When the messenger arrived with the note, the astonishment and joy was incredible. Coccei instantly rode to the mill, followed by a detachment of the guards.

He

(A) "This intimation, which the king gave to his assassins, may at first sight appear extraordinary and unaccountable, but was really dictated by the greatest address and judgment. He apprehended with reason, that, on the sight of a Russian guard, they would instantly put him to death with their sabres, and fly; whereas by informing them of the danger they incurred, he in some measure gained their confidence: in effect, this behaviour of the king seemed to soften them a little, and made them believe he did not mean to escape from them."

Poland.

He met Kofinski at the door with his sabre drawn, who admitted him as soon as he knew him. The king had sunk into a sleep, caused by his fatigue; and was stretched on the ground, covered with the miller's cloak. Coceci immediately threw himself at his majesty's feet, calling him his sovereign, and kissing his hand. It is not easy to paint or describe the astonishment of the miller and his family, who instantly imitated Coceci's example, by throwing themselves on their knees (B). The king returned to Warsaw in General Coceci's carriage, and reached the palace about five in the morning. His wound was found not to be dangerous; and he soon recovered the bruises and injuries which he had suffered during this memorable night. So extraordinary an escape is scarce to be paralleled in history, and affords ample matter of wonder and surprise.

It is natural to inquire what is become of Kofinski, the man who saved his majesty's life, and the other conspirators. He was born in the palatinate of Cracow, and of mean extraction; having assumed the name of *Kofinski* (C), which is that of a noble family, to give himself credit. He had been created an officer in the troops of the confederates under Pulaski. It would seem as if Kofinski began to entertain the idea of preserving the king's life from the time when Lukawski and Strawenski abandoned him; yet he had great struggles with himself before he could resolve on this conduct, after the solemn engagements into which he had entered. Even after he had conducted the king back to Warsaw, he expressed more than once his doubts of the propriety of what he had done, and some remorse for having deceived his employers. He was detained under a very strict confinement, and obliged to give evidence against his two companions Lukawski and Strawenski, who were beheaded, his majesty having obtained for them from the diet a mitigation of the horrible punishment which the laws of Poland inflict upon regicides. About a week after the execution of these conspirators, Kofinski was sent out of Poland, after the king had settled upon him an annual pension which he enjoyed at Semigallia in the papal territories.

110
Is received
at Warsaw
with demonstrations
of joy.

111
Partition
of Poland
projected
by the king
of Prussia,

Upon the king's return to Warsaw he was received with the utmost demonstrations of joy. Every one exclaimed with rapture, "The king is alive!" and all struggled to get near him, to kiss his hand, or even to touch his clothes. But neither the virtues nor the popularity of the sovereign could allay the factious spirit of the Poles, nor prevent the dismemberment of his kingdom.

"The partition of Poland was first projected by the king of Prussia. Polish or Western Prussia had long been an object of his ambition: exclusive of its fertility, commerce, and population, its local situation rendered it highly valuable to that monarch; it lay between his German dominions and Eastern Prussia, and while possessed by the Poles, cut off at their will all communication between them." The period was now arrived when the situation of Poland seemed to promise the easy acquisition of this valuable province. "Frederic pur-

sued it, however, with all the caution of an able politician. On the commencement of the troubles, he showed no eagerness to interfere in the affairs of this country; and although he had concurred with the empress of Russia in raising Stanislaus Augustus to the throne of Poland, yet he declined taking any active part in his favour against the confederates. Afterwards, when the whole kingdom became convulsed throughout with civil commotions (1769), and desolated likewise by the plague, he, under pretence of forming lines to prevent the spreading of the infection, advanced his troops into Polish Prussia, and occupied that whole district.

"Though now completely master of the country, and by no means apprehensive of any formidable resistance from the disunited and distracted Poles, yet, as he was well aware that the security of his new acquisition depended upon the acquiescence of Russia and Austria, he planned the partition of Poland. He communicated the project to the emperor, either upon their interview at Nies in Silesia in 1769, or in that of the following year at Neustadt in Austria; from whom the overture met with a ready concurrence. To induce the empress of Russia to acquiesce in the same project, he dispatched his brother Henry to Petersburg, who suggested to the empress that the house of Austria was forming an alliance with the Porte, with which she was then at war; that if such alliance took place, it would create a most formidable combination against her; that, nevertheless, the friendship of that house was to be purchased by acceding to the partition; that upon this condition the emperor was willing to renounce his connection with the Grand Signior, and would suffer the Russians to prosecute the war without interruption. Catherine, anxious to push her conquests against the Turks, and dreading the interposition of the emperor in that quarter; perceiving likewise, from the intimate union between the courts of Vienna and Berlin, that it would not be in her power, at the present juncture, to prevent the intended partition: closed with the proposal, and selected no inconsiderable portion of the Polish territories for herself. The treaty was signed at Petersburg in the beginning of February 1772, by the Russian, Austrian, and Prussian plenipotentiaries. It would be tedious to enter into a detail of the pleas urged by the three powers in favour of their several demands; it would be no less uninteresting to lay before the reader the answers and remonstrances of the king and senate, as well as the appeals to the other states which had guaranteed the possessions of Poland. The courts of London, Paris, Stockholm, and Copenhagen, remonstrated against the usurpations; but remonstrances without assistance could be of no effect. Poland submitted to the dismemberment not without the most violent struggles, and now for the first time felt and lamented the fatal effects of faction and discord.

A diet being demanded by the partitioning powers, in order to ratify the cession of the provinces, it met on the 19th of April 1773; and such was the spirit of the members, that, notwithstanding the deplorable situation of

Poland.

112
Who gains
over the
emperor
and the
empress to
his mea-
sures.

113
Poland dis-
membered.

(B) "I have been (says Mr Wraxall) at this mill, rendered memorable by so singular an event. It is a wretched Polish hovel, at a distance from any house. The king has rewarded the miller to the extent of his wishes in building him a mill upon the Vistula, and allowing him a small pension."

(C) His real name was John Kutma.

Poland.

of their country, the threats and bribes of the three powers, the partition-treaty was not carried through without much difficulty. For some time the majority of the nuncios appeared determined to oppose the dismemberment, and the king firmly persisted in the same resolution. The ambassadors of the three courts enforced their requisitions by the most alarming menaces, and threatened the king with deposition and imprisonment. They also gave out by their emissaries, that in case the diet continued refractory, Warsaw should be pillaged. This report was industriously circulated, and made a sensible impression upon the inhabitants. By menaces of this sort, by corrupting the marshal of the diet, who was accompanied with a Russian guard; in a word, by bribes, promises, and threats, the members of the diet were at length prevailed on to ratify the dismemberment.

114
Provinces
seized by
the three
partition-
ing powers.

Of the dismembered countries, the Russian province is the largest, the Austrian the most populous, and the Prussian the most commercial. The population of the whole amounts to near 5,000,000 souls; the first containing 1,500,000, the second 2,500,000, and the third 860,000. Western Prussia was the greatest loss to Poland, as by the dismemberment of that province the navigation of the Vistula entirely depends upon the king of Prussia: by the loss consequently of this district a fatal blow was given to the trade of Poland; for his Prussian majesty has laid such heavy duties upon the merchandize passing to Dantzic, as greatly to diminish the commerce of that town, and to transfer a considerable portion of it to Memel and Konigsburgh.

The partitioning powers, however, did less injury to the republic by dismembering its fairest provinces, than by perpetuating the principles of anarchy and confusion, and establishing on a permanent footing that exorbitant liberty which is the parent of faction, and has proved the decline of the republic. Under pretence of amending the constitution, they have confirmed all its defects, and have taken effectual precautions to render this unhappy country incapable of emerging from its present deplorable state, as has been lately seen in the failure of the most patriotic attempt that was perhaps ever made by a king to reform the constitution of his kingdom.

115
The kings
of Poland
originally
hereditary.

The kings of Poland were anciently hereditary and absolute; but afterwards became elective and limited, as we find them at this day. In the reign of Louis, towards the end of the 14th century, several limitations were laid on the royal prerogative. In that of Casimir IV. who ascended the throne in 1446, representatives from the several palatinates were first called to the diet; the legislative power till then having been lodged in the states, and the executive in the king and senate. On the decease of Sigismund Augustus, it was enacted by law, "That the choice of a king for the future should perpetually remain free and open to all the nobles of the kingdom;" which law has accordingly been hitherto observed.

116
Afterwards
elective.

Universal
History.

"As soon as the throne is vacant, all the courts of justice, and other ordinary springs of the machine of government, remain in a state of inaction, and all the authority is transferred to the primate, who, in quality of interrex, has in some respects more power than the king himself; and yet the republic takes no umbrage at it, because he has not time to make himself formidable.

He notifies the vacancy of the throne to foreign princes, which is in effect proclaiming that a crown is to be disposed of; he issues the *universalia*, or circular letters for the election; gives orders to the starosts (a sort of military officers who have great authority, and whose proper business it is to levy the revenue) to keep a strict guard upon the fortified places, and to the grand-generals to do the same upon the frontiers, towards which the army marches.

Poland.

"The place of election is the field of Wola, at the gates of Warsaw. All the nobles of the kingdom have a right of voting. The poles encamp on the left side of the Vistula, and the Lithuanians on the right, each under the banners of their respective palatinates, which makes a sort of civil army; consisting of between a hundred and fifty and two hundred thousand men, assembled to exercise the highest act of freedom. Those who are not able to provide a horse and a sabre stand behind on foot, armed with scythes, and do not seem at all less proud than the rest, as they have the same right of voting.

117
Place and
manner of
the elec-
tion.

"The field of election is surrounded by a ditch with three gates, in order to avoid confusion, one to the east for Great Poland, another to the south for Little Poland, and a third to the west for Lithuania. In the middle of the field, which is called *Kohau*, is erected a great building of wood, named the *szopa* or hall for the senate, at whose debates the deputies are present, and carry the result of them to the several palatinates. The part which the marshal acts upon this occasion is very important; for, being the mouth of the nobility, he has it in his power to do great service to the candidates; he is also to draw up the instrument of election, and the king elect must take it only from his hand.

"It is prohibited, upon pain of being declared a public enemy, to appear at the election with regular troops, in order to avoid all violence. But the nobles, who are always armed with pistols and sabres, commit violence against one another, at the time that they cry out 'liberty!'

"All who aspire openly to the crown are expressly excluded from the field of election, that their presence may not constrain the voters. The king must be elected *nemine contradicente*, by all the suffrages without exception. The law is founded upon this principle, that when a great family adopts a father, all the children have a right to be pleased. The idea is plausible in speculation; but if it was rigorously kept to, Poland could have no such thing as a lawful king. They therefore give up a real unanimity, and content themselves with the appearance of it; or rather, if the law, which prescribes it, cannot be fulfilled by means of money, they call in the assistance of the sabre.

"Before they come to this extremity, no election can possibly be carried on with more order, decency, and appearance of freedom. The primate in few words recapitulates to the nobles on horseback the respective merit of the candidates; he exhorts them to choose the most worthy, invokes heaven, gives his blessing to the assembly, and remains alone with the marshal of the diet, while the senators disperse themselves into the several palatinates, to promote an unanimity of sentiments. If they succeed, the primate goes himself to collect the votes, naming once more all the candidates. 'Szoda (answer the nobles), that is the man we choose;'

and

Po'and.

and instantly the air resounds with his name, with cries of *vivat*, and the noise of pistols. If all the palatines agree in their nominations, the primate gets on horseback; and then the profoundest silence succeeding to the greatest noise, he asks three times if all are satisfied? and after a general approbation, three times proclaims the king; and the grand-marshal of the crown repeats the proclamation three times at the three gates of the camp. How glorious a king this, if endued with royal qualities! and how incontestable his title in the suffrages of a whole people! But this sketch of a free and peaceable election is by no means a representation of what usually happens. The corruption of the great, the fury of the people, intrigues and factions, the gold and the arms of foreign powers, frequently fill the scene with violence and blood."

118
The *pacsa*
conventa.

Before the king is proclaimed, the *pacsa conventa* is read aloud to him, which on his knees at the altar he swears to observe. As this contract, which is drawn up, methodized, and approved, by the senate and nobility, may be deemed the great charter of Poland, we shall enumerate the principal articles of which it consists. These are, that the king shall not attempt to encroach on the liberty of the people, by rendering the crown hereditary in his family; but that he shall preserve all the customs, laws, and ordinances, respecting the freedom of election: that he shall ratify all treaties subsisting with foreign powers which are approved by the diet: that it shall be his chief study to cultivate peace, preserve the public tranquillity, and promote the interest of the realm: that he shall not coin money except in the name of the republic, nor appropriate to himself the advantages arising from coinage: that in declaring war, concluding peace, making levies, hiring auxiliaries, or admitting foreign troops upon any pretext within the Polish dominions, the consent of the diet and senate shall be necessary: that all offices and preferments shall be given to the natives of Poland and Lithuania; and that no pretence shall excuse or palliate the crime of introducing foreigners into the king's council or the departments of the republic: that the officers of his majesty's guards shall be Poles or Lithuanians; and that the colonel shall absolutely be a native of Poland, and of the order of nobility: that all the officers shall be subordinate to the authority of the mareschal: that no individual shall be vested with more employments than the law allows: that the king shall not marry without the approbation of the senate; and that the household of the queen shall be determined and regulated by the republic: that the sovereign shall never apply his private signet to acts and papers of a public nature: that the king shall dispose of the offices both of the court and of the republic; and regulate with the senate the number of forces necessary for the defence of the kingdom: that he shall administer justice by the advice of the senate and his council: that the expences of his civil list shall be the same with those of his predecessors: that he shall fill up all vacancies in the space of six weeks: that this shall be his first business in the diet, obliging the chancellor to publish his appointments in due form: that the king shall not diminish the treasure kept at Cracow; but, on the contrary, endeavour to augment that and the number of the crown-jewels: that he shall borrow no money without the consent of the diet: that he shall not equip a naval force without

the consent and full approbation of the republic: that he shall profess the Roman Catholic faith, promote, maintain, and defend it, through all the Polish dominions: and finally, that all their several liberties, rights, and privileges, shall be preserved to the Poles and Lithuanians in general, and to all the districts and provinces contained within each of these great divisions, without change, alteration, or the smallest violation, except by the consent of the republic. To these articles a variety of others are added, according to circumstances and the humour of the diet; but what we have recited form the standing conditions, which are scarce ever altered or omitted.

Po'and.

The diet of Poland is composed of the king, the senate, bishops, and the deputies of the nobility or gentry of every palatinate, called, in the collective capacity, *comitia togata*; that is, when the states assemble in the city without arms and horses; or *comitia paludata*, when they meet in the fields armed, as during an interregnum, at the diet of election. It is a prerogative of the crown to assemble the diet at any particular place, except on occasion of a coronation, which the custom of the country requires should be celebrated at the capital. For a number of years, indeed, the diet regularly assembled at Warsaw; but, on complaint made by the Lithuanians, it was agreed, that every third diet should be held at Grodno. "When it is proposed to hold a general diet, the king, or, in case of an interregnum, the primate, issues writs to the palatines of the several provinces, specifying the time and place of the meeting. A sketch likewise is sent of the business to be deliberated on by the assembly; the senate is consulted in this particular, and six weeks are allowed the members to prepare themselves for the intended session. It is remarkable, that the diet never sits more than six weeks in the most critical conjunctures and pressing emergencies: they have been known to break up in the middle of an important debate, and to leave the business to a future meeting. This custom hath been justly esteemed one of the greatest defects of the Polish constitution, which probably owes its origin to convenience, but is now superstitiously observed from whim and caprice. On receipt of the king's writ, the palatine communicates the meeting of the diet to all the castellans, starostas, and other inferior officers and gentry within his jurisdiction, requiring them to assemble on a certain day to elect deputies, and take into consideration the business specified in the royal summons. These meetings are called *petty diets*, *dietines*, or *lantage*, in the language of the country; every gentleman possessing three acres of land having a vote, and matters being determined by a majority; whereas in the general diet decrees are only valid when the whole body is unanimous. Every palatinate has three representatives, though the business devolves on one called a *nuncio*, who is elected for his ability and experience; and the other two are added only to give weight to this leading member, and do honour by their magnificent appearance to the palatinate they represent. As these deputies, since the reign of Casimir III. have seats in the diet, it naturally divides the general assembly into two bodies, the upper and lower; the one being composed of the senate, the superior clergy, and the great officers; the other of the representatives of the palatinates, who prepare all business for the superior body.

119
The diet of
Poland, and

120
Dietines.

"The

Poland.

"The first business of the assembly is to choose a marshal; upon which occasion the debates and tumults run so high, that the whole time for the session of the diet is often consumed in altercation and wrangling about the election of a speaker, who has now nothing farther to do than return quietly to his own home. After his election, he kisses the king's hand; and the chancellor, as the royal representative, reports the matters to be deliberated by the diet. Then the marshal acquaints the king with the instructions of the deputies from their constituents, the grievances which they would have redressed, and the abuses they require to be remedied. He likewise requests of his majesty to fill up the vacant offices and benefices, according to law; and he is answered by a set speech from the chancellor, who reports the king's inclination to satisfy his people, as soon as he hath consulted his faithful senate. There is something very peculiarly absurd in some of the customs observed by the Polish diet: one in particular merits attention. Not only an unanimity of voices is necessary to pass any bill, and constitute a decree of the diet, but every bill must likewise be assented to unanimously, or none can take effect. Thus, if out of twenty bills one should happen to be opposed by a single voice, called

121
Absurd customs observed in the diet.

122
The liberum veto.

liberum veto, all the rest are thrown out, and the diet meets, deliberates, and debates, for six weeks to no purpose.

"To add to the other inconveniences attending the constitution of the diet of Poland, a spirit of venality in the deputies, and a general corruption, hath seized all ranks and degrees in that assembly. Here, as in some other countries, the cry of liberty is kept up for the sake of private interest. Deputies come with a full resolution of profiting by their patriotism, and not lowering their voice without a gratification. Determined to oppose the most salutary measures of the court, they either withdraw from the assembly, protest against all that shall be transacted in their absence, or else excite such a clamour as renders it necessary for the court to silence them by some lucrative pension, donation, or employment. Thus not only the business of the assembly is obstructed by its own members, but frequently by largesses from neighbouring powers, and sometimes by the liberality of an open enemy, who has the art of distributing his money with discretion.

123
The senate of Poland.

"Perhaps the most respectable department of the Polish government is the senate, composed of the bishops, palatines, castellans, and ten officers of state, who derive a right from their dignities of sitting in that assembly; in all amounting to 144 members, who are styled *senators of the kingdom* or *counsellors of the state*, and have the title of *excellency*, a dignity supported by no pension or emoluments necessarily annexed. The senate presides over the laws, is the guardian of liberty, the judge of right, and the protector of justice and equity. All the members, except the bishops, who are senators *ex officio*, are nominated by the king, and they take an oath to the republic before they are permitted to enter upon their functions. Their honours continue for life: at the general diet they sit on the right and left of the sovereign, according to their dignity, without regard to seniority. They are the mediators between the monarch and the subject, and, in conjunction with the king, ratify all the laws passed by the nobility. As a senator is bound by oath to maintain the liberties

of the republic, it is thought no disrespect to majesty that they remind the prince of his duty. They are his counsellors, and this freedom of speech is an inseparable prerogative of their office."

Poland.

Such was the constitution of Poland before it was new-modelled by the partitioning powers. That it was a very bad constitution needs no proof; but those foreign reformers did not improve it. For two centuries at least, the Poles have with great propriety denominated their government a republic, because the king is so exceedingly limited in his prerogative, that he resembles more the chief of a commonwealth than the sovereign of a powerful monarchy. That prerogative, already too confined to afford protection to the peasants, groaning under the aristocratic tyranny of the nobles, was, after the partition treaty, still further restrained by the establishment of the *permanent council*, which was vested with the whole executive authority, leaving to the sovereign nothing but the name. The permanent council consists of 36 persons, elected by the diet out of the different orders of nobility; and though the king, when present, presides in it, he cannot exert a single act of power but with the consent of the majority of persons, who may well be called his *colleagues*.

124
The permanent council.

That the virtuous and accomplished Stanislaus should labour to extricate himself and the great body of the people from such unparalleled oppression, and that the more respectable part of the nation should wish to give to themselves and their posterity a better form of government, was surely very natural and very meritorious. The influence of the partitioning powers was indeed exerted to make the king contented with his situation. His revenues, which before did not exceed L. 100,000, were now increased to three times that sum. The republic likewise agreed to pay his debts, amounting to upwards of L. 400,000. It bestowed on him also, in hereditary possession, four starosties, or governments of castles, with the districts belonging to them; and reimbursed him of the money he had laid out for the state. It was also agreed, that the revenues of the republic should be enhanced to 33 millions of florins (near two millions Sterling), and the army should consist of 30,000 men. Soon after the conclusion of the peace with Turkey, the empress of Russia also made the king a present of 250,000 rubles, as a compensation for that part of his dominions which fell into her hands.

These bribes, however, were not sufficient to blind the eyes of Stanislaus, or to cool the ardour of his patriotism. He laboured for posterity, and with such apparent success, that on the 3d of May 1791, a new constitution of the government of Poland was established by the king, together with the confederate states assembled in double number to represent the Polish nation. That this was a perfect constitution, we are far from thinking; but it was probably as perfect as the inveterate prejudices of the nobles would admit of. It deviated as little as possible from the old forms, and was drawn up in 11 articles, respecting the government of the republic; to which were added 21 sections, regulating the dietines or primary assemblies of Poland.

125
A new constitution established in 1791.

Of this constitution, the first article established the Roman Catholic faith, with all its privileges and immunities, as the dominant national religion; granting to all other people, of whatever persuasion, peace in matters of faith, and the protection of government. The

126
Substance of the first five articles of it.

Poland.

second article guaranteed to the nobility or the equestrian order, all the privileges which it enjoyed under the kings of the house of Jagellan. The third and fourth articles granted to the free royal towns internal jurisdictions of their own; and exempted the peasants from slavery, declaring every man free as soon as he sets his foot on the territory of the republic. The fifth article, after declaring, that in civil society all power should be derived from the will of the people, enacted that the government of the Polish nation should be composed of three distinct powers, the *legislative*, in the states assembled; the *executive*, in the king and the council of inspection; and the *judicial* power, in the jurisdictions existing, or to be established. The sixth and seventh articles, as being of more importance, we shall give in the words of the constitution itself.

127
The diet to consist of two houses, viz. the house of nuncios,

VI. *The Diet, or the legislative power*, shall be divided into two houses, viz. the house of nuncios, or deputies, and the house of senate, where the king is to preside. The former being the representative and central point of supreme national authority, shall possess the pre-eminence in the legislature; therefore all bills are to be decided first in this house.

1. *All General Laws*, viz. constitutional, civil, criminal, and perpetual taxes; concerning which matters, the king is to issue his propositions by the circular letters sent before the dietines to every palatinate and to every district for deliberation, which coming before the house with the opinion expressed in the instructions given to their representatives, shall be taken the first for decision.

2. *Particular Laws*, viz. temporal taxes; regulations of the mint; contracting public debts; creating nobles, and other casual recompenses; reparation of public expences, both ordinary and extraordinary; concerning war; peace; ratification of treaties, both political and commercial; all diplomatic acts and conventions relative to the laws of nations; examining and acquitting different executive departments, and similar subjects arising from the accidental exigencies and circumstances of the state; in which the propositions, coming directly from the throne into the house of nuncios, are to have preference in discussion before the private bills.

128
And the house of senate.

In regard to the house of senate, it is to consist of bishops, palatines, castellans, and ministers, under the presidency of the king, who shall have but one vote, and the casting voice in case of parity, which he may give either personally, or by a message to the house. Its power and duty shall be,

1. Every general law that passes formally through the house of nuncios, is to be sent immediately to this, which is either accepted, or suspended till farther national deliberation, by a majority of votes, as prescribed by law. If accepted, it becomes a law in all its force; if suspended, it shall be resumed at the next diet; and if it is then agreed to again by the house of nuncios, the senate must submit to it.

3. Every particular law or statute of the diet in matters above specified, as soon as it has been determined by the house of nuncios, and sent up to the senate, the votes of both houses shall be jointly computed, and the majority, as described by law, shall be considered as a decree and the will of the nation. Those senators and ministers who, from their share in executive power, are accountable to the republic, cannot have an active voice

Vol. XV. Part I.

in the diet, but may be present, in order to give necessary explanations to the states.

Poland.

These ordinary legislative diets shall have their uninterrupted existence, and be always ready to meet; renewable every two years. The length of sessions shall be determined by the law concerning diets. If convened out of ordinary session upon some urgent occasion, they shall only deliberate on the subject which occasioned such a call, or on circumstances which may arise out of it.

No law or statute enacted by such ordinary diet can be altered or annulled by the same. The complement of the diet shall be composed of the number of persons in both houses to be determined hereafter.

The law concerning the dietines or primary elections, as established by the present diet, shall be regarded as a most essential foundation of civil liberty.

The majority of votes shall decide every thing, and everywhere; therefore we abolish, and utterly annihilate, *liberum veto*, all sorts of confederacies and confederate diets, as contrary to the spirit of the present constitution, as undermining the government, and as being ruinous to society.

129
The liberum veto abolished.

Willing to prevent, on one hand, violent and frequent changes in the national constitution, yet, considering on the other, the necessity of perfecting it, after experiencing its effects on public prosperity, we determine the period of every 25 years for an extraordinary constitutional diet, to be held purposely for the revision and such alterations of the constitution as may be found requisite: which diet shall be circumscribed by a separate law hereafter.

130
Extraordinary diet for revising the constitution.

VII. The most perfect government cannot exist or last without an effectual executive power. The happiness of the nation depends on just laws, but the good effects of laws flow only from their execution. Experience has taught us, that the neglecting this essential part of government has overwhelmed Poland with disasters.

Having, therefore, secured to the free Polish nation the right of enacting laws for themselves, the supreme inspection over the executive power, and the choice of their magistrates, we entrust to the king and his council the highest power of executing the laws. This council shall be called *Sraz*, or the council of inspection.

131
Powers of the king and council of inspection.

The duty of such executive power shall be to watch over the laws, and to see them strictly executed according to their import, even by the means of public force, should it be necessary. All departments and magistracies are bound to obey its directions. To this power we leave the right of controlling such as are refractory, or of punishing such as are negligent in the execution of their respective offices.

This executive power cannot assume the right of making laws, or of their interpretation. It is expressly forbidden to contract public debts; to alter the repartition of the national income, as fixed by the diet; to declare war; to conclude definitively any treaty, or any diplomatic act; it is only allowed to carry on negotiations with foreign courts, and facilitate temporary occurrences, always with reference to the diet.

The crown of Poland we declare to be elective in regard to families, and it is settled so for ever.

132
Crown elective in regard to families;

Having experienced the fatal effects of interregna, families; periodically

P p

Poland

133
But hereditary in each family till its extinction.

periodically subverting government, and being desirous of preventing for ever all foreign influence, as well as of insuring to every citizen a perfect tranquillity, we have, from prudent motives, resolved to adopt hereditary succession to our throne: therefore we enact and declare, that, after the expiration of our life, according to the gracious will of the Almighty, the present elector of Saxony shall reign over Poland, and in his person shall the dynasty of future kings of Poland begin. We reserve to the nation, however, the right of electing to the throne any other house or family, after the extinction of the first.

134
Coronation oath.

Every king, on his accession to the throne, shall take a solemn oath to God and the nation, to support the present constitution, to fulfil the *pacta conventa*, which will be settled with the present elector of Saxony, as appointed to the crown, and which shall bind him in the same manner as former ones.

135
King's person sacred:

The king's person is sacred and inviolable; as no act can proceed immediately from him, he cannot be in any manner responsible to the nation; he is not an absolute monarch, but the father and the head of the people; his revenues, as fixed by the *pacta conventa*, shall be sacredly preserved. All public acts, the acts of magistracies, and the coin of the kingdom, shall bear his name.

136
His particular powers.

The king, who ought to possess every power of doing good, shall have the right of pardoning those that are condemned to death, except the crimes be against the state. In time of war, he shall have the supreme command of the national forces: he may appoint the commanders of the army, however, by the will of the states. It shall be his province to patent officers in the army, and other dignitaries, consonant to the regulations hereafter to be expressed, to appoint bishops, senators, and ministers, as members of the executive power.

137
Members of the council of inspection.

The king's council of inspection is to consist, 1. Of the primate, as the head of the clergy, and the president of the commission of education, or the first bishop in ordine. 2. Of five ministers, viz. the minister of police, minister of justice, minister of war, minister of finances, and minister for the foreign affairs. 3. Of two secretaries to keep the protocols, one for the council, another for the foreign department; both, however, without decisive vote. The hereditary prince coming of age, and having taken the oath to preserve the constitution, may assist at all sessions of the council, but shall have no vote therein. The marshal of the diet, being chosen for two years, has also a right to sit in this council, without taking any share in its resolves; for the end only to call together the diet, always existing, in the following case: should he deem, from the emergencies hereunder specified, the convocation of the diet absolutely necessary, and the king refusing to do it, the marshal is bound to issue his circular letters to all nuncios and senators, adducing real motives for such meeting.

138
Powers of the marshal.

The cases demanding such convocation of the diet are the following: 1. In a pressing necessity concerning

the law of nations, and particularly in case of a neighbouring war. 2. In case of an internal commotion, menacing with the revolution of the country, or of a collision between magistratures. 3. In an evident danger of general famine. 4. In the orphan state of the country, by demise of the king, or in case of the king's dangerous illness. All the resolutions of the council of inspection are to be examined by the rules above mentioned. The king's opinion, after that of every member in the council has been heard, shall decisively prevail. Every resolution of this council shall be issued under the king's signature, countersigned by one of the ministers sitting therein; and thus signed, shall be obeyed by all executive departments, except in cases expressly exempted by the present constitution.

Should all the members refuse their countersign to any resolution, the king is obliged to forego his opinion; but if he should persist in it, the marshal of the diet may demand the convocation of the diet; and if the king will not, the marshal himself shall send his circular letters as above. Ministers composing this council cannot be employed at the same time in any other commission or department.

If it should happen that two thirds of secret votes in both houses demand the changing of any person, either in the council, or any executive department, the king is bound to nominate another. Willing that the council of inspection should be responsible to the nation for their actions, we decree, that when these ministers are denounced and accused before the diet (by the special committee appointed for examining their proceedings) of any transgression of positive law, they are answerable with their persons and fortunes. Such impeachments being determined by a simple majority of votes, collected jointly from both houses, shall be tried immediately by the comital tribunal, where the accused are to receive their final judgment and punishment, if found guilty; or to be honourably acquitted on sufficient proof of innocence.

In order to form a necessary organization of the executive power, we establish hereby separate commissions, connected with the above council, and subjected to obey its ordinations. These commissions are, 1. of education; 2. of police; 3. of war; 4. of treasury. It is through the medium of these four departments that all the particular orderly commissions (n), as established by the present diet, in every palatinate and district, shall depend on, and receive all orders from, the council of inspection, in their respective duties and occurrences.

The eighth article regulates the administration of justice, beginning with a very sensible declaration, that the judicial power is incompatible with the legislative, and that it cannot be administered by the king. It therefore constitutes primary courts of justice for each palatinate or district, composed of judges chosen at the diet; and appoints higher tribunals, erected one in each of the three provinces into which the kingdom is divided, with which appeals may be lodged from the primary

139
Commissions of education, police, &c.

140
Administration of justice.

(n) Orderly commissions are newly instituted; each palatinate and district chooses a certain number of commissaries; their office lasts two years; their principal duty is to maintain police and good order in their district; to put into execution decrees and regulations of supreme departments; to collect taxes; to keep cash; to make such payments as assigned by the commission of finances; to protect citizens from the military oppression; to furnish recruits, besides many other duties of internal management.

Poland.

141
Regency
on certain
occasions.

many courts. It appoints likewise for the trial of persons accused of crimes against the state, one supreme general tribunal for all classes, called a *comitial tribunal* or court, composed of persons chosen at the opening of every diet. The ninth article provides a regency during the king's minority, in case of his settled alienation of reason, or upon the emergency of his being made a prisoner of war. This regency was to be composed of the council of inspection, with the queen at their head, or, in her absence, the primate of the kingdom. The tenth article enjoins, that the education of the king's sons shall be entrusted to the king with the council, and a tutor appointed by the states; and the eleventh regulates the army in such a manner, as to prevent it from being employed to overturn the constitution.

142
The elec-
tion and
duties of
nuncios.

The regulation of the dietines contains nothing that can be interesting to a British reader, except what relates to the election and duties of nuncios or representatives to the general diet. And here it is enacted, that persons having a right to vote are all nobles of the equestrian order; i.e. 1. All hereditary proprietors of landed property, or possessed of estates by adjudication for a debt, paying territorial tax to government: sons also of such proprietors during the life of their parents, before the ex-division of patrimony. 2. Brothers inheriting estates before they have shared their succession. 3. All mortgages who pay 100 florins (50 shillings) of territorial tax per year from their possessions. 4. All life-holders of lands paying territorial tax to the same amount. 5. All nobles in the army possessed of such qualifying estates have a vote in their respective districts in time of peace, and properly furloughed by their commanders. 6. Legal possession is understood to be qualifying when it has been formerly acquired and actually enjoyed for twelve calendar months previously.

Persons who have no right to vote are, 1. Those of the equestrian order that are not actually possessed of a property, as described in the foregoing article. 2. Such as hold royal, ecclesiastical, or noble lands, even with right of inheritance, but on condition of some duty or payment to their principals, consequently dependent thereon. 3. Gentry possessing estates on feudal tenure, called *ordynackie*, as being bound to certain personal service thereby. 4. All renters of estates that have no other qualifying property. 5. Those that have not accomplished 18 years of age. 6. *Crimine notati*, and those that are under a decree passed in default, even in the first instance, for having disobeyed any judicial court.

143
Persons e-
ligible and
not eli-
gible.

Every person of the equestrian order that pays territorial tax to government for his freehold, let it be ever so small, is eligible to all elective offices in his respective district.

Gentlemen actually serving in the army, even possessed of landed hereditary estate, must have served six complete years before they are eligible to the office of a nuncio only. But this condition is dispensed with in favour of those that have filled before some public function.

Whoever is not personally present at the dietine; whoever has not completed 23 years of age; whoever has not been in any public function, nor passed the biennial office of a commissary in the orderly commission; those that are exempted by law from obligations of *scarta bellatus*, which subjects all newly-nobilitated per-

sons to certain civil restrictions until the next generation; and, lastly, all those against whom may be objected a decree in *contumaciam* in a civil cause; are not eligible.

During the business of election, the president who opened the meeting, with the rest of the committee, except those who are assessors, shall prepare instructions for procedure; and in regard to the propositions sent by the king and the council of inspection, these instructions shall be worded thus: "Our nuncios shall vote affirmative to the article N;" or, "Our nuncios shall vote negative to the article N," in case it is found contrary to the opinion of the dietine: and should any amendment or addition be deemed necessary and agreed on, it may be inserted in the instructions at the end of the relative proposition.

At the meeting of the dietines, after the diet has sat, the nuncios are bound to appear before their constituents, and to bring their report of the whole proceedings of that assembly; first, respecting the acts of legislature; next, with respect to the particular projects of their palatinate or district recommended to them by the instructions.

It is at these dietines that nuncios, after they have rendered to their constituents a clear account of their proceedings and of the diet, may be either confirmed or changed, and new ones elected in their stead till the general election for the following ordinary diet.

New nuncios are chosen, 1. In the room of the deceased. 2. In the room of those that are become senators or ministers of state. 3. In case of resignation. 4. In the room of such as are disqualified by the diet. 5. When any of the assembly desires a new election, to substitute another nuncio in the room of one expressly pointed out; which request must be made in writing, signed by 12 members besides, and be delivered to the marshal of the dietine. In this last case, the marshal is to read the name of the nuncio objected to, and to make the following proposition: "Shall the nuncio N be confirmed in his function? or, Shall there be a new election made in his stead?" The opinion of the meeting being taken by a division, the majority shall decide the question, and be declared by the marshal. If the majority approves the conduct of the nuncio; the marshal and the assessors shall certify this confirmation on the diploma; and in case of disapprobation, the marshal shall declare the vacancy, and begin the form of a new election.

Such are the outlines of the Polish constitution established by the king and the confederates in 1791. It will not bear a comparison with that under which Britons have the happiness to live; but it is surely infinitely superior to that motley form of government which, for a century past, has rendered Poland a perpetual scene of war, tumult, tyranny, and rebellion. Many of the corrupt nobles, however, perceiving that it would curb their ambition, deprive them of the base means which they had long enjoyed of gratifying their avarice by setting the crown to sale, and render it impossible for them to continue with impunity their tyrannical oppression of the peasants, protested against it, and withdrew from the confederates. This was nothing more than what might have been expected, or than what the king and his friends undoubtedly did expect. But the malcontents were not satisfied with a simple protest; they preferred their complaints to the empress of Russia,

Po'and.

147
And op-
posed by
the Rus-
sians.

* New An-
nual Regi-
ster, 1792.

148
The nation
rises to
maintain its
independ-
ence.

149
Spirit of
the nobi-
lity.

sia, who, ready on all occasions, and on the slightest pretence, to invade Poland, poured her armies into the republic, and surrounding the king and the diet with ferocious soldiers, compelled them, by the most furious and indecent menaces, to undo their glorious labour of love, and to restore the constitution as settled after the partition treaty.

Of the progress of the Russians in this work of darkness, our readers will be pleased with the following manly and indignant narrative, taken from a periodical work * of acknowledged merit.

" It was on the 21st of April 1792, that the diet received the first notification from the king, of the inimical and unjust intentions of Russia. He informed them that, without the shadow of pretence, this avowed enemy of the rights of mankind had determined to invade the territory of the republic with an army of 60,000 men. This formidable banditti, commanded by generals Soltikow, Michelson, and Kosakowski, was afterwards to be supported by a corps of 20,000, and by the troops then acting in Moldavia, amounting to 70,000. The king, however, professed that he was not discouraged, and declared his readiness to put himself at the head of the national troops, and to terminate his existence in a glorious contest for the liberties of his country. Then, and not before, the diet decreed the organisation of the army, and its augmentation to 100,000. The king and the council of inspection were invested with unlimited authority in every thing that regarded the defence of the kingdom. Magazines were ordered to be constructed when it was too late, and quarters to be provided for the army.

" The diet and the nation rose as one man to maintain their independence. All private animosities were obliterated, all private interests were sacrificed; the greatest encouragements were held forth to volunteers to enroll themselves under the national standard, and it was unanimously decreed by the diet, that all private losses should be compensated out of the public treasury.

" On the 18th of May, the Russian ambassador delivered a declaration, which was worthy of such a cause. It was a tissue of falsehood and hypocrisy. It asserted, that this wanton invasion, which was evidently against the sense of almost every individual Polisher, was meant entirely for the good of the republic. It censured the precipitancy with which the new constitution was adopted, and ascribed the ready consent of the diet to the influence of the Warsaw mob. It represented the constitution as a violation of the principles on which the Polish republic was founded—complained of the licentiousness with which the sacred name of the empress was treated in some speeches of the members; and concluded by professing, that on these accounts, and in behalf of the emigrant Poles, her imperial majesty had ordered her troops to enter the territories of the republic.

" At the moment this declaration was delivered to the diet, the Russian troops, accompanied by Counts Potocki, Rzewuski, Branicki, and a few Polish apostates, appeared upon the frontiers, and entered the territories of the republic in several columns, before the close of the month. The spirit manifested by the nobility was truly honourable. Some of them delivered in their plate to the mint. Prince Radzvil engaged voluntarily to furnish 10,000 stand of arms, and another a train of artillery. The

courage of the new and hastily embodied soldiers corresponded with the patriotism of their nobles. Prince Poniatowski, nephew to the king, was appointed commander in chief; and though his force was greatly inferior to the enemy, it must be confessed that he made a noble stand. On the 24th of May, the enemy's Cossacks were repulsed, and pursued by the patrols of the republic to the very entrenchments. On the 26th, about one o'clock, the piquets of the republic discovered a large body of Don Cossacks approaching the outposts; and a squadron of cavalry, commanded by Lieutenant Kwawniewski, supported by Lieutenant Golejowski with two squadrons more, in all about 300, marched out to meet them. They attacked the Cossacks with success, but pursued them with more valour than prudence to the side of a wood, where they found themselves drawn into an ambuscade, and surrounded by 2000 horse, two battalions of chasseurs, and six pieces of cannon. The intrepid Poles bravely fought their way through the Russian line, and killed upwards of 200 of the enemy. The Poles in this engagement lost 100 men and two officers; one of whom, Lieutenant Kwawniewski, was wounded and made prisoner. The remainder of the detachment reached their quarters in safety.

" Perhaps the history of man can scarcely furnish an instance of perfidy, meanness, and duplicity, equal to that which was manifested by Prussia on this occasion. By the treaty of defensive alliance, solemnly contracted between the republic of Poland and the king of Prussia, and ratified on the 23d of April 1790, it is expressly stipulated, 'That the contracting parties shall do all in their power to guarantee and preserve to each other reciprocally the whole of the territories which they respectively possess: That, in case of menace or invasion from any foreign power, they shall assist each other with their whole force, if necessary:—and by the sixth article, it is further stipulated, 'that if any foreign power whatever shall presume to interfere in the internal affairs of Poland, his Prussian majesty shall consider this as a case falling within the meaning of the alliance, and shall assist the republic according to the tenor of the fourth article,' that is, with his whole force. What then is the pretext for abandoning this treaty? It is, that the empress of Russia has shown a decided opposition to the order of things established in Poland on the third of May 1791, and is provoked by Poland presuming to put herself into a posture to defend it.—It is known, however, by the most authentic documents, that nothing was effected on the third of May 1791, to which Prussia had not previously assented, and which she did not afterwards sanction; and that Prussia, according to the assertion of her own king, did not intimate a single doubt respecting the revolution till one month (and according to the Prussian minister till six months) after it had taken place; in short, to use the monarch's own words as fully explanatory of his double politics, "not till the general tranquillity of Europe permitted him to explain himself."—Instead, therefore, of assisting Poland, Prussia insultingly recommended to Poland to retrace her steps; in which case, she said that she would be ready to attempt an accommodation in her favour. This attempt was never made, and probably never intended; for the empress pursued her measures.

The duchy of Lithuania was the great scene of action in the beginning of the war; but the Russians had made little

Poland.

150

Conduct of
the court
of Berlin.

P-land.

151
War with
Russia.

little progress before the middle of the month of June. On the 10th of that month, General Judycki, who commanded a detachment of the Polish troops, between Mire and Swierzna, was attacked by the Russians; but, after a combat of some hours, he obliged them to retire with the loss of 500 men dead on the field.—The general was desirous of profiting by this advantage, by pursuing the enemy, but was prevented by a most violent fall of rain. On the succeeding day, the Russians rallied again to the attack; and it then too fatally appeared, that the Poles were too young and undisciplined to contend with an inferior force against experienced troops and able generals. By a masterly manœuvre, the Russians contrived to surround their antagonists, at a moment when the Polish general supposed that he had obliged the enemy to retreat; and though the field was contested with the utmost valour by the troops of the republic, they were at length compelled to give way, and to retire towards Nieswiez.

On the 14th another engagement took place near Lubar, on the banks of the river Sluez, between a detachment of the Russian grand army and a party of Polish cavalry, dispatched by Prince Joseph Poniatowski, to intercept the enemy. The patriotic bravery of the Poles was victorious in this contest; but upon reconnoitering the force of the enemy, the prince found himself incapable of making a successful stand against such superior numbers. He therefore gave orders to strike the camp at Lubar, and commenced a precipitate retreat. During their march, the Polish rear was harassed by a body of 4000 Russians, till arriving at Boruskowee, the wooden bridge unfortunately gave way, under the weight of the cavalry. The enemy, in the mean time, brought their artillery to play upon the rear of the fugitives, who lost upwards of 250 men. The Polish army next directed its course toward Zielime, where meeting, on the 17th, with a reinforcement from Zaslow, it halted to give battle to the enemy. The Russians were upwards of 17,000 strong, with 24 pieces of cannon, and the force of the republic much inferior. After a furious contest from seven in the morning till five in the afternoon, the Russians were at length obliged to retreat, and leave the field of battle in possession of the patriots. The Russians were computed to have lost 4000 men in this engagement, and the Poles about 1100.

Notwithstanding these exertions, the Poles were obliged gradually to retire before their numerous and disciplined enemies. Nieswiez, Wilna, Minsk, and several other places of less consequence, fell into their hands one after another. On a truce being proposed to the Russian general Kochowski, the proposal was haughtily rejected; while the desertion of vice brigadier Rudnicki and some others, who preferred dishonour to personal danger, proclaimed a tottering cause. The progress of the armies of Catharine was marked with devastation and cruelty, while, such was the aversion of the people both to the cause and the manner of conducting it, that, as they approached, the country all around became a wilderness, and scarcely a human being was to be seen.

In the mean time, a series of little defeats, to which the inexperience of the commanders, and the intemperate valour of new raised troops, appear to have greatly contributed, served at once to distress and to dispirit

these defenders of their country. Prince Poniatowski continued to retreat, and on the 17th of July, his rear being attacked by a very superior force, it suffered a considerable loss, though the skill and courage of General Kosciuszko enabled him to make a most respectable defence. On the 18th, a general engagement took place between the two armies. The Russian line extended opposite Dubienka, along the river Bog, as far as Opalin. The principal column, consisting of 14,000 men, was chiefly directed against the division of General Kosciuszko, which consisted of 5000 men only. After a most vigorous resistance, in which the Russians lost upwards of 4000 men, and the troops of the republic only some hundreds, the latter was compelled to give way before the superior numbers of the enemy, and to retire further into the country.

This unequal contest was at last prematurely terminated. The king, whose benevolent intentions were, perhaps, overpowered by his mental imbecility, and whose age and infirmities, probably, rendered him unequal to the difficulties and dangers which must attend a protracted war, instead of putting himself, according to his first resolve, at the head of his army, determined, at once, to surrender at discretion. On the 23d of July, he summoned a council of all the deputies at that moment in Warsaw. He laid before them the last dispatches from the empress, which insisted upon total and unreserved submission. He pointed out the danger of a dismemberment of the republic, should they delay to throw themselves upon the clemency of the empress, and to intreat her protection. He mentioned the fatal union of Austria and Prussia with Russia; and the disgraceful supineness manifested by every other court in Europe.

Four citizens, the intrepid and patriotic Malachowski, the princes Sapieha, Radzvil, and Soltan, vehemently protested against these dastardly proceedings; and the following evening a company of gentlemen from the different provinces assembled for the same purpose. The assembly waited immediately on these four distinguished patriots, and returned them their acknowledgements for the spirit and firmness with which they had resisted the usurpations of despotism. The submission of the king to the designs of Russia was no sooner made known, than Poland was bereft of all her best and most respectable citizens. Malachowski as marshal of the diet, and Prince Sapieha grand marshal of Lithuania, entered strong protests on the journals of the diet against these hostile proceedings, and declared solemnly that the diet legally assembled in 1788 was not dissolved.

On the second of August a confederation was formed at Warsaw, of which the grand apostate, Potocki, was chosen Marshall. The acts of this confederation were evidently the despotic dictates of Russia, and were calculated only to restore the ancient abuses, and to place the country under the aggravated oppression of a foreign yoke.

It is remarkable, that at the very moment when Poland was surrendering its liberties to its despotic invaders, the generous sympathy of Great Britain was evinced by a liberal subscription, supported by all the most respectable characters in the nation, of every party and of every sect, for the purpose of assisting the king and the republic to maintain their independence. Though

Poland.

152
The king
proposes
submission.153
Confederation
at
Warsaw over-
ruled by
Russia, re-
stores the
former con-
stitution.

Poland.

the benevolent design was frustrated, the fact remains on record as a noble testimony of the spirit of Britons in the cause of freedom, of the indignation which fills every British heart at the commission of injustice, and of the liberality with which they are disposed to assist those who suffer from the oppression of tyrants.

154
The em-
press sei-
zes upon
part of the
Polish ter-
ritory.

Not satisfied with restoring the old wretched constitution, the empress of Russia seized upon part of the territory which, at the last partition, she and her coadjutors had left to the republic; and her ambassador entering into the diet with a crowd of armed ruffians, compelled the king and that assembly to grant the form of legality to her usurpations. The nation, however, did not submit. General Kosciusko kept together a few retainers, whom he was soon enabled to augment to the number of an army; and seizing on the person of the king, he has ever since waged against Russia a war, of which, it must be confessed, the object is doubtful. His enemies accuse him of cherishing in the republic the principles of the French Jacobins; and some late occurrences give a countenance to the accusation. Yet it is known he protested at first that his aim reached no farther than to restore the constitution of 1791; and if public report may be credited, an insurrection has lately taken place in Great Poland, or South Prussia, in favour of that constitution. If other Poles have been driven to democracy, they have only, with the common weakness of human nature, run from one extreme to another; and in flying from the tyranny of their invaders, have fallen into the horrors of anarchy. That Kosciusko will succeed against the powerful empire of Russia, there is not the smallest probability; and if there were, the court of Berlin, to complete its character, has withdrawn from the most honourable alliance in which it was ever engaged, and seems to have employed the subsidy which it received from Great Britain for the maintenance of that alliance, to co-operate with the empress in annihilating the kingdom and republic of Poland. What will be the ultimate fate of that unhappy country, and its amiable sovereign, it is impossible to say; but appearances at present indicate a division of the whole territory among the three hostile powers who formerly robbed it of some of its most valuable provinces; and when that division is made, the virtuous Stanislaus may be removed to a better world by the dagger, by the bowl, by the gripe of a giant, or by a red-hot spit!

156
Air, cli-
mate, &c.
of Poland.

The air of this kingdom is cold in the north, but temperate in the other parts both in summer and winter, and the weather in both more settled than in many other countries. The face of the country is for the most part level, and the hills are but few. The Crapack or Carpathian mountains separate it from Hungary on the south. The soil is very fruitful both in corn and pasturage, hemp and flax. Such is the luxuriance of the pastures in Podolia, that it is said one can hardly see the cattle that are grazing in the meadows. Vast quantities of corn are yearly sent down the Vistula to Dantzic, from all parts of Poland, and bought up chiefly by the Dutch. The eastern part of the country is full of woods, forests, lakes, marshes, and rivers; of the last of which, the most considerable in Poland are, the Vistula, Nieper, Nietter, Duna, Bog, Warta, and Memel. The metals found in this country are iron and lead, with some tin, gold, and silver; but there are no mines of the two last wrought at pre-

sent. The other products of Poland are most sorts of precious stones, ochre of all kinds, fine rock-crystal; Muscovy glass, talc, alum, saltpetre, amber, pitecoal, quicksilver, spar, sal-gem, lapis calaminaris, and vitriol. In Lesser Poland are salt-mines, which are the chief riches of the country, and bring most money into the exchequer. In the woods, which consist mostly of oak, beech, pine, and fir-trees, besides the more common wild beasts, are elks, wild asses, wild oxen or uri, lynxes, wild horses, wild sheep with one horn, 'bisons, hyænas, wild goats, and buffaloes. In the meadows and fenny ground is gathered a kind of manna; and the kermes-berries produced in this country are used both in dying and medicine.

The inhabitants consist of nobles, citizens, and peasants. The first possess great privileges, which they en-joy partly by the indulgence of their kings, and partly by ancient custom and prescription. Some of them have the title of *prince*, *count*, or *baron*; but no superiority or pre-eminence on that account over the rest, which is only to be obtained by some public post or dignity. They have the power of life and death over their vassals; pay no taxes; are subject to none but the king; have a right to all mines and salt-works on their estates; to all offices and employments, civil, military, and ecclesiastic; cannot be cited or tried out of the kingdom; may choose whom they will for their king, and lay him under what restraints they please by the *Pacta Conventa*; and none but they and the burghers of some particular towns can purchase lands. In short, they are almost entirely independent, enjoying many other privileges and prerogatives besides those we have specified; but if they engage in trade, they forfeit their nobility.

The Polish tongue is a dialect of the Slavonic: (see *PHILOLOGY*, n° 222.). It is neither copious nor harmonious. Many of the words, as they are written, have not a single vowel in them; but the High Dutch and Latin are understood and spoken pretty commonly, though incorrectly. The language in Lithuania differs much from that of the other provinces. True learning, and the study of the arts and sciences, have been little attended to in Poland, till of late they began to be regarded with a more favourable eye, and to be not only patronized, but cultivated by several of the nobles and others, both laymen and ecclesiastics.

There are two archbishops in the kingdom, viz. Archbishops of Gnesna and Laopol, and about a dozen bishops. The archbishop of Gnesna is always a cardinal, and primate of the kingdom. The prevailing religion is Popery, but there are great numbers of Lutherans, Calvinists, and Greeks, who are called *Dissidents*, and by the laws of the kingdom were intitled to toleration; but were much oppressed till very lately. The Jews are indulged with great privileges, and are very numerous in Poland; and in Lithuania, it is said there are a multitude of Mahometan Tartars. We may judge of the numbers of Jews in this country by the produce of their annual poll-tax, which amounts to near 57,000 rixdollars.

There are few or no manufactures in the kingdom, if we except some linen and woollen clothes and hardwares; and the whole trade is confined to the city of Dantzic, and other towns on the Vistula or Baltic.

Before the present troubles the king's revenue was

Poland.

157
Different
classes of
inhabitants.

158
Language.

159
Arch-
bishops,
&c.

160
Manufac-
tures.

161
Revenue.
all

Poland all clear to himself; for he paid no troops, not even his
 ||
 Pole. own guards; but all the forces, as well as the officers
 of state, were paid by the republic. The public revenues
 arose chiefly from the crown-lands, the salt-mines
 in the palatinate of Cracow, from the rents of Marien-
 burg, Dirschau, and Regenhuis, from the government of
 Cracow, and district of Niepolomiez, and from ancient
 tolls and customs, particularly those of Elbing and Dant-
 zic. From what sources those revenues now arise, it is
 difficult to say; but Prussia has got possession of the
 most lucrative customs.

162
 Order of
 night-
 hood.

163
 Forces.

The order of the White Eagle was instituted by Au-
 gustus II. in the year 1705. Its ensign is a cross of
 gold enamelled with red, and appendant to a blue rib-
 bon. The motto, *Pro fide, rege, et lege*.

The standing forces of Poland are divided into the
 crown-army, and that of Lithuania, consisting of horse
 and foot, and amounting to between 20,000 and
 30,000 men. These troops are mostly cantoned on the
 crown-lands, and in Poland are paid by a capitation
 or poll-tax; but in Lithuania other taxes are levied
 for this purpose. Most of the foot are Germans. On
 any sudden and imminent danger, the whole body of
 the nobility, with their vassals, are obliged to appear
 in the field on horseback; and the cities and towns fur-
 nish a certain number of foot-soldiers, with carriages,
 and military stores: but for want of proper arms, pro-
 visions, subordination, and discipline, and by being at
 liberty after a few weeks to return home, this body has
 proved but of little advantage to the republic. Dant-
 zic is the only place in the Polish dominions that de-
 serves the name of a fortress, and it is now in the pos-
 session of Prussia. Foreign auxiliaries are not to be
 brought into the kingdom, nor the national troops to
 march out of it, without the consent of the states.

Such was the military establishment of Poland be-
 fore the partition treaty. What it has been since, and
 is at present, we cannot positively say.

164
 Character
 of the
 people.

The Poles are personable men, and have good com-
 plexions. They are esteemed a brave, honest people,
 without dissimulation, and exceedingly hospitable. They
 clothe themselves in furs in winter, and over all they
 throw a short cloak. No people keep grander equi-
 pages than the gentry. They look upon themselves as
 so many sovereign princes; and have their guards, bands
 of music, and keep open houses: but the lower sort of
 people are poor abject wretches, in the lowest state of
 slavery. The exercises of the gentry are hunting, rid-
 ing, dancing, vaulting, &c. They reside mostly up-
 on their estates in the country; and maintain them-
 selves and families by agriculture, breeding of bees,
 and grazing.

POLAR, in general, something relating to the poles
 of the world, or poles of the artificial globes.

POLAR Regions, those parts of the world which lie
 near the north and south poles. See the article POLE.

POLARITY, the quality of a thing considered as
 having poles, or a tendency to turn itself into one
 certain posture; but chiefly used in speaking of the
 magnet.

POLE (Reginald), cardinal, and archbishop of Can-
 terbury, a younger son of Sir Rich. Pole, Lord Mon-
 tague, was born at Stoverton castle, in Staffordshire, in
 the year 1500. At seven years of age he was sent to a
 Carthusian monastery at Shene, near Richmond in Surry;
 and thence, when he was about 12 years old, removed

to Magdalen college in Oxford, where, by the instruc-
 tions of the celebrated Lineacre and Latimer, he made
 considerable progress in learning. In 1515 he took the
 degree of bachelor of arts, and was admitted to deacon's
 orders some time after: in 1517, he was made preben-
 dary of Salisbury, and in 1519 dean of Wimborne and
 dean of Exeter. We are not surpris'd at this young
 nobleman's early preferments, when we consider him as
 the kinsman of Henry VIII. and that he was bred to
 the church by the king's special command.

Being now about the age of 19, he was sent, ac-
 cording to the fashion of the times, to finish his studies
 at Padua in Italy, where he resided some time in great
 splendor, having a handsome pension from the king.
 He returned to England in 1525, where he was most
 graciously received at court, and universally admired
 for his talents and address; but preferring study and
 sequestration to the pleasures of a court, he retired to
 the Carthusian convent at Shene, where he had continu-
 ed about two years, when the pious king began to
 divulge his scruples of conscience concerning his mar-
 riage with Catharine of Spain. Pole foresaw that this
 affair would necessarily involve him in difficulties; he
 therefore determined to quit the kingdom, and accord-
 ingly obtained leave to visit Paris. Having thus avoid-
 ed the storm for the present, he returned once more to
 his convent at Shene; but his tranquillity was again
 interrupted by the king's resolution to shake off the
 pope's supremacy, of which Pole's approbation was
 thought indispensably necessary. How he managed in
 this affair, is not very clear. However, he obtained
 leave to revisit Italy, and his pension was continued for
 some time.

The king, having now divorced Queen Catharine,
 married Anne Boleyn, and being resolved to throw off
 the papal yoke, ordered Dr Richard Sampson to write
 a book in justification of his proceedings, which he sent
 to Pole for his opinion. To this Pole, secure in the
 pope's protection, wrote a scurrilous answer, entitled
Pro Unitate Ecclesiastica, and sent it to the king; who
 was so offended with the contents, that he withdrew
 his pension, stripped him of all his preferments, and
 procured an act of attainder to be passed against him.
 In the mean time, Pole was created a cardinal, and sent
 nuncio to different parts of Europe. King Henry made
 several attempts to have him secured and brought to
 England, but without effect. At length the pope fix-
 ed him as legate at Viterbo, where he continued till
 the year 1543, when he was appointed legate at the
 council of Trent, and was afterwards employed by the
 pope as his chief counsellor.

Pope Paul III. dying in 1549, Pole was twice elect-
 ed his successor, and, we are told, twice refused the pa-
 pal dignity: first, because the election was made in too
 great haste; and the second time, because it was done
 in the night. This delicacy in a cardinal is truly won-
 derful: but the intrigues of the French party seem to
 have been the real cause of his miscarriage; they started
 many objections to Pole, and by that means gained time
 to procure a majority against him. Cardinal Maria de
 Monte obtained the triple crown; and Pole, having kis-
 sed his slipper, retired to the convent of Magazune
 near Verona, where he continued till the death of Ed-
 ward VI. in the year 1553. On the accession of queen
 Mary, Pole was sent legate to England, where he was
 received by her majesty with great veneration, and con-
 ducted

Pole.

ducted to the archbishop's palace at Lambeth, poor Cranmer being at that time prisoner in the Tower. He immediately appeared in the House of Lords, where he made a long speech; which being reported to the commons by their speaker, both these obsequious houses concurred in an humble supplication to be reconciled to the see of Rome. They presented it on their knees to her majesty, who interceded with the cardinal, and he graciously condescended to give them absolution. This business being over, the legate made his public entry into London, and immediately set about the extirpation of heresy. The day after the execution of Cranmer, which he is said, though we believe falsely, to have advised, he was consecrated archbishop of Canterbury. In the same year, 1556, he was elected chancellor of the university of Oxford, and soon after of Cambridge; both which he visited, by his commissioners. He died of a double quartan ague in the year 1558, about 16 hours after the death of the queen; and was buried in the cathedral of Canterbury.

As to his character, the Romish writers ascribe to him every virtue under heaven: even Bishop Burnet is extremely lavish in his praise, and attributes the cruelties of Mary's reign to the advice of Gardiner. In this Mr Hume agrees with the bishop, and represents Pole as the advocate of toleration. By every impartial account, he seems to have been a man of mild manners, and of real worth, though undoubtedly a zealous member of the church of Rome.—He wrote, *Pro unitate ecclesiastica, De ejusdem potestate*, A treatise on Justification, and various other tracts.

Mr Philips published a very well written, though a very partial account, of Pole's life, to which Gloucester Ridley replied. This last work, which is entitled a *Review of Mr Philips's Life of Reginald Pole*, was published in 1766. It is a complete confutation of the former, and is a very learned and temperate vindication of the doctrines of the Reformation.

POLE, in astronomy, that point in the heavens round which the whole sphere seems to turn. It is also used for a point directly perpendicular to the centre of any circle's plane, and distant from it by the length of a radius.

POLE, in geography, one of the points on which the terraqueous globe turns; each of them being 90 degrees distant from the equator, and, in consequence of their situation, the inclination of the earth's axis, and its parallelism during the annual motion of our globe round the sun, having only one day and one night throughout the year.

It is remarkable, that though the *north* in Hebrew, Greek, Latin, and French, derives its name from gloom, obscurity, and darkness, the poles enjoy more light than any other part of the world. The ancients believed the north to be covered with thick darkness; Strabo tells us, that Homer, by the word *σκοτος*, which properly signifies *obscurity* or *darkness*, meant the *north*; and thus Tibullus, speaking of the north, says,

Illic et densa tellus absconditur umbra.

Paneg. ad Missal.

The Arabians call the northern ocean the *dark sea*; the Latins gave the name of *Aquilo* to the north wind, because *aquilus* signifies *black*; and the French call it *la bise*, from *bis* "black." According to the ancients, the

Cimmerians lived in darkness, because they were placed near the north. But all this is mere prejudice; for there are no places in the world that enjoy light longer than the arctic and antarctic poles; and this is accounted for by considering the nature of twilight. In the torrid zone, and under the line, night immediately follows the setting of the sun, without any sensible twilight; whereas the twilight begins and continues increasing in proportion as places are distant from the equator or approach the pole. To this long twilight we must add the *aurora borealis*, which appears in the northern regions, Greenland, &c. in clear nights, at the beginning of the new moon, casting a light equal to that of full moon. See Gassendi in the *life of Peyresc*, book iii. and La Perere in his *Account of Greenland*. There is also long moonlight at the poles during winter. See *ASTRONOMY*, n° 373. But though there is really more light in the polar regions than elsewhere, yet owing to the obliquity with which the rays of the sun fall upon them, and the great length of winter night, the cold is so intense, that those parts of the globe which lie near the poles have never been fully explored, though the attempt has been repeatedly made by the most celebrated navigators. Indeed their attempts have chiefly been confined to the northern regions; for with regard to the south pole, there is not the same incitement to attempt it. The great object for which navigators have ventured themselves in these frozen seas, was to find out a more quick and more ready passage to the East Indies*; and this hath been attempted three several ways: one by coasting along the northern parts of Europe and Asia, called the *north-east passage*; another, by sailing round the northern part of the American continent, called the *north-west passage*; and the third, by sailing directly over the pole itself.

We have already given a short account of several unsuccessful attempts which have been made from England to discover the first two of these. See *NORTH-WEST Passage*, and *NORTH-EAST Passage*. But before we proceed to the third, we shall make a few further observations on them, and mention the attempts of some other nations.

During the last century, various navigators, Dutchmen particularly, attempted to find out the *north-east passage*, with great fortitude and perseverance. They always found it impossible, however, to surmount the obstacles which nature had thrown in the way. Subsequent attempts are thought by many to have demonstrated the impossibility of ever sailing eastward along the northern coast of Asia; and this impossibility is accounted for by the increase of cold in proportion to the extent of land. See *AMERICA*, n° 3—5. This is indeed the case in temperate climates; but much more so in those frozen regions where the influence of the sun, even in summer, is but small. Hence, as the continent of Asia extends a vast way from west to east, and has besides the continent of Europe joined to it on the west, it follows, that about the middle part of that tract of land the cold should be greater than anywhere else. Experience has determined this to be fact; and it now appears, that about the middle part of the northern coast of Asia the ice never thaws; neither have even the hardy Russians and Siberians themselves been able to overcome the difficulties they met with in that part of their voyage. In order to make this the more plain and

Pole.

And why.

* See Cook, p. 395. col. 2.

3 Attempts to find out the north-east passage.

4 Why it is impossible to sail along the north-east coast of Asia.

The poles enjoy much light;

Pole.

* See
Cook's
Discoveries,
11° 109. and
118.

and the following accounts more intelligible, we shall observe, that from the north-western extremity of Europe, called the *North Cape*, to the north-eastern extremity of Asia, called the *Promontory of the Tschutski**, is a space including about 160 degrees of longitude, viz. from 40 to 200 east from Ferro: the port of Archangel lies in about 57 degrees east longitude, Nova Zembla between 70 and 95; which last is also the situation of the mouth of the great river Oby. Still farther eastward are the mouths of the rivers Jenisey in 100°; Piafida in 105°; Chatanga in 124°; Lena, which has many mouths, between 134° and 142°; Indigirka in 162°; and the Kovyma in 175°. The coldest place in all this tract, therefore, ought to be that between the mouths of the Jenisey and the Chatanga; and indeed here the unfurmoutable difficulty has always been, as will appear from the following accounts of the voyages made by the Russians with a view to discover the north-east passage.

5
Voyage of
Morzov-
vieff, &c.

In 1734, lieutenant Morzovieff sailed from Archangel towards the river Oby, but could scarce advance 20 degrees of longitude during that season. The next summer he passed through the straits of Weygatz into the sea of Kara; but did not double the promontory which separates the sea of Kara from the bay or mouth of Oby. In 1738, the lieutenants Malgyn and Shurakoff doubled that promontory with great difficulty, and entered the bay of Oby. Several unsuccessful attempts were made to pass from the bay of Oby to the Jenisey; which was at last effected, in 1738, by two vessels commanded by lieutenants Offzin and Koskeleff. The same year the pilot Feodor Menin sailed eastwards from the Jenisey to the mouth of the Piafida: but here he was stopped by the ice; and finding it impossible to force a passage, he returned to the Jenisey.

6
Of Pront-
shitcheff.

In July 1735, lieutenant Prontshitcheff sailed down the river Lena, in order to pass by sea to the mouth of the Jenisey. The western mouths of the Lena were so choaked up with ice, that he was obliged to pass thro' the most easterly one; and was prevented by contrary winds from getting out till the 13th of August. Having steered north-west along the islands which lie scattered before the mouths of the Lena, he found himself in lat. 70. 4.; yet even here he saw pieces of ice from 24 to 60 feet in height, and in no place was there a free channel left of greater breadth than 100 or 200 yards. His vessel being much damaged, he entered the mouth of the Olenek, a small river near the western mouth of the Lena; and here he continued till the ensuing season, when he got out in the beginning of August. But before he could reach the mouth of the Chatanga, he was so entirely surrounded and hemmed in with ice, that it was with the utmost difficulty he could get loose. Observing then a large field of ice stretching into the sea, he was obliged to sail up the Chatanga. Getting free once more, he proceeded northward, doubled the cape called *Taimura*, and reached the bay of that name, lying in about 115° east from Ferro; from thence he attempted to proceed westward along the coast. Near the shore were several small islands, between which and the shore the ice was immoveably fixed. He then directed his course towards the sea, in order to pass round the chain of islands. At first he found the sea more free to the north of these islands, but observed much ice lying between them. At last he

VOL. XV. Part I.

arrived at what he took to be the last of the islands, lying in lat. 77. 25. Between this island and the shore, as well as on the other side of the island which lay most to the north, the ice was firm and immoveable. He attempted, however, to steer still more to the north; and having advanced about six miles, he was prevented by a thick fog from proceeding: this fog being dispersed, he saw nothing everywhere but ice, which at last drove him eastward, and with much danger and difficulty he got to the mouth of the Olenek on the 29th of August.

Pole.

Another attempt to pass by sea from the Lena to the Of Chariton Lap-
Jenisey was made in 1739 by Chariton Laptieff, but with no better success than that just mentioned. This voyager relates, that between the rivers Piafida and Taimura, a promontory stretches into the sea, which he could not double, the sea being entirely frozen up before he could pass round.

Besides the Russians, it is certain that some English Mr Cox's
and Dutch vessels have passed the island of Nova Zem- observations.
bla into the sea of Kara: "But (says Mr Cox in his Account of the Russian voyages) no vessel of any nation has ever passed round that cape which extends to the north of the Piafida, and is laid down in the Russian charts in about 78° lat. We have already seen that no Russian vessel has ever got from the Piafida to the Chatanga, or from the Chatanga to the Piafida; and yet some authors have positively asserted that this promontory has been sailed round. In order therefore to elude the Russian accounts, which clearly assert the contrary, it is pretended that Gmelin and Muller have purposely concealed some parts of the Russian journals, and have imposed on the world by a misrepresentation of facts. But without entering into any dispute upon this head, I can venture to affirm, that no sufficient proof has been as yet advanced in support of this assertion; and therefore, until some positive information shall be produced, we cannot deny plain facts, or give the preference to hearsay evidence over circumstantial and well attested accounts."

The other part of this north-east passage, viz. from Of the na-
the Lena, to Kamtschatka, though sufficiently difficult vigation
and dangerous, is yet practicable; as having been once from the
performed, if we may believe the accounts of the Rus- Lena to
sians. According to some authors indeed, says Mr Cox, ka. Kamtschat.
this navigation has been open a century and an half; and several vessels at different times have passed round the north-eastern extremity of Asia. But if we consult the Russian accounts, we shall find that frequent expeditions have been unquestionably made from the Lena to the Kovyma, but that the voyage from the Kovyma round Tschutskoi Nofis into the Eastern Ocean has been performed but once. According to Mr Muller, this formidable cape was doubled in the year 1648. The material incidents of this remarkable voyage are as follow.

"In 1648 seven ketches, or vessels, sailed from the Voyage of
mouth of the river Kovyma, in order to penetrate into Deshneff,
the Eastern Ocean. Of these, four were never more Ankudi-
heard of: the remaining three were commanded by Sim- noff, &c.
mon Deshneff, Gerasim Ankudinoff, and Fedot Alex-
eeff. Deshneff and Ankudinoff quarrelled before their departure concerning the division of profits and honours to be acquired by their voyage; which, however, was not so easily accomplished as they had imagined. Yet

Qq

Deshneff

Pole.

Deshneff in his memorials makes no mention of obstructions from the ice, nor probably did he meet with any; for he takes notice that the sea is not every year so free from ice as it was at that time. The vessels sailed from the Kovyma on the 20th of June, and in September they reached the promontory of the Tschutski, where Ankudinoff's vessel was wrecked, and the crew distributed among the other two. Soon after this the two vessels lost sight of each other, and never joined again. Deshneff was driven about by tempestuous winds till October, when he was shipwrecked considerably to the south of the Anadyr. Having at last reached that river, he formed a scheme of returning by the same way that he had come; but never made the attempt. As for Alexeeff, after being also shipwrecked, he had died of the scurvy, together with Ankudinoff; part of the crew were killed by the savages, and a few escaped to Kamschatka, where they settled."

* See Cook's Discoveries, n^o 95—100.

From Captain* Cook's voyage towards the north-eastern parts of Asia, it appears, that it is possible to double the promontory of Tschutski without any great difficulty: and it now appears, that the continents of Asia and America are separated from one another but by a narrow strait, which is free from ice; but, to the northwards, that experienced navigator was everywhere stopped by ice in the month of August, so that he could neither trace the American continent farther than to the latitude of 70°, nor reach the mouth of the river Kovyma on the Asiatic continent; though it is probable that this might have been done at another time when the situation of the ice was altered either by winds or currents.

11
Insurmountable obstacles in the north-east passage.

On the whole, therefore, it appears that the insurmountable obstacle in the north-east passage lies between the rivers Piafida and Chatanga; and unless there be in that space a connection between the Asiatic and American continents, there is not in any other part. Ice, however, is as effectual an obstruction as land: and though the voyage were to be made by accident for once, it never could be esteemed a passage calculated for the purposes of trade, or any other beneficial purpose whatever.

12
Of the north-west passage.

With regard to the north-west passage, the same difficulties occur as in the other. Captain Cook's voyage has now assured us, that if there is any strait which divides the continent of America into two, it must lie in a higher latitude than 70°, and consequently be perpetually frozen up. If a north-west passage can be found then, it must be by sailing round the whole American continent, instead of seeking a passage through it, which some have supposed to exist in the bottom of Baffin's Bay. But the extent of the American continent to the northward is yet unknown; and there is a possibility of its being joined to that part of Asia between the Piafida and Chatanga, which has never yet been circumnavigated* It remains therefore to consider, whether there is any possibility of attaining the wished for passage by sailing directly north, between the eastern and western continents.

* See Cook's Discoveries, n^o 11.

13
Barrington's arguments in favour of a possibility of reaching the pole.

Of the practicability of this method, the Honourable Daines Barrington is very confident, as appears by several tracts which he published in the years 1775 and 1776, in consequence of the unsuccessful attempts made of reaching by Captain Phipps, now Lord Mulgrave. See *NORTH-EAST Passage*, p. 108. col. 1. top of the page.—In these

Pole.

tracts he instances a great number of navigators who have reached very high northern latitudes; nay, some who have been at the pole itself, or gone beyond it.—These instances are, 1. One Captain Thomas Robertson assured our author, that he had been in latitude 82½°, that the sea was open, and he was certain that he could have reached the latitude of 83°.—2. From the testimony of Captain Cheyne, who gave answers to certain queries drawn up by Mr Dalrymple concerning the polar seas, it appears that he had been in the latitude of 82°.—3. One Mr Watt informed our author, that when he was 17 years of age, at that time making his first voyage with Captain McCallam, a bold and skilful navigator, who commanded a Scotch whale-fishing ship, as during the time that the whales are supposed to copulate no fishing can be carried on, the captain resolved to employ that interval in attempting to reach the north pole. He accordingly proceeded without the least obstruction to 83½°, when the sea was not only open to the northward, but they had seen no ice for the last three degrees; but while he still advanced, the mate complained that the compass was not steady, and the captain was obliged with reluctance to give over his attempt.—4. Dr Campbell, the continuator of Harris's voyages, informed Mr Barrington, that Dr Dallie, a native of Holland, being in his youth aboard a Dutch ship of war which at that time was usually sent to superintend the Greenland fishery, the captain determined, like the Scotchman above-mentioned, to make an attempt to reach the pole during the interval between the first and second fisheries. He penetrated, according to the best of Dr Campbell's recollection, as far as 88°; when the weather was warm, the sea free from ice, and rolling like the bay of Biscay. Dallie now pressed the captain to proceed: but he answered, that he had already gone too far, and should be blamed in Holland for neglecting his station; upon which account he would suffer no journal to be kept, but returned as soon as possible to Spitzbergen.—5. In the year 1662-3, Mr Oldenburg, then secretary of the Royal Society, was ordered to register a paper, entitled "Several inquiries concerning Greenland, answered by Mr Gray, who had visited these parts." The 19th of these queries is the following: How near hath any one been known to approach the pole?—The answer is, "I once met upon the coast of Greenland a Hollander that swore he had been half a degree from the pole, showing me his journal, which was also attested by his mate; where they had seen no ice or land, but all water."—6. In Captain Wood's account of a voyage in quest of the north-east passage, we have the following account of a Dutch ship which reached the latitude of 89°. "Captain Goulden, who had made above 30 voyages to Greenland, did relate to his majesty, that being at Greenland some 20 years before, he was in company with two Hollanders to the eastward of Edge's island; and that the whales not appearing on the shore, the Hollanders were determined to go farther northward; and in a fortnight's time returned, and gave it out that they had failed into the latitude 89°, and that they did not meet with any ice, but a free and open sea, and that there run a very hollow grown sea like that of the Bay of Biscay. Mr Goulden being not satisfied with the bare relation, they produced him four journals out of the two ships, which testified the same, and that they all agreed within four minutes."

Pole.

Pole.

14
Why we
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minutes."—7. In the Philosophical Transactions for 1675 we have the following passage: "For it is well known to all that sail northward, that most of the northern coasts are frozen up for many leagues, though in the open sea it is not so, *no nor under the pole itself*, unless by accident." In which passage the having reached the pole is alluded to as a known fact, and as such stated to the Royal Society.—8. Mr Miller, in his Gardener's Dictionary, mentions the voyage of one Captain Johnson, who reached 88 degrees of latitude. Mr Barrington was at pains to find a full account of this voyage; but met only with the following passage in Buffon's Natural History, which he takes to be a confirmation of it. "I have been assured by persons of credit, that an English captain, whose name was Monson, instead of seeking a passage to China between the northern countries, had directed his course to the pole, and had approached it within two degrees, where there was an open sea, without any ice." Here he thinks that Mr Buffon has mistaken Johnson for Monson.—9. A map of the northern hemisphere, published at Berlin (under the direction of the Academy of Sciences and Belles Letters), places a ship at the pole, as having arrived there according to the Dutch accounts.—10. Moxon, hydrographer to Charles II. gives an account of a Dutch ship having been two degrees beyond the pole, which was much relied on by Wood. This vessel found the weather as warm there as at Amsterdam.

Besides these, there are a great number of other testimonies of ships which have reached the lat. of 81, 82, 83, 84 (A), &c.; from all which our author concludes, that if the voyage is attempted at a proper time of the year, there would not be any great difficulty of reaching the pole. Those vast pieces of ice which commonly obstruct the navigators, he thinks, proceed from the mouths of the great Asiatic rivers which run northward into the frozen ocean, and are driven eastward and westward by the currents. But though we should suppose them to come directly from the pole, still our author thinks that this affords an undeniable proof that the pole itself is free from ice; because, when the pieces leave it, and come to the southward, it is impossible that they can at the same time accumulate at the pole.

The extreme cold of the winter air on the continents of Asia and America has afforded room for suspicion, that at the pole itself, and for several degrees to the southward of it, the sea must be frozen to a vast depth in one solid cake of ice; but this Mr Barrington refutes from several considerations. In the first place, he says, that on such a supposition, by the continual intensity of the cold, and the accumulation of snow and frozen vapour, this cake of ice must have been increasing in thickness since the creation, or at least since the deluge; so that now it must be equal in height to the highest mountains in the world, and be visible at a great distance. Besides, the pieces broken off from the sides of such an immense mountain must be much thicker than any ice that is met with in the northern ocean; none of which is above two yards in height above the surface of the water, those immense pieces called *ice-mountains* being always formed on land.

Again, the system of nature is so formed, that all parts of the earth are exposed for the same length of time, or nearly so, throughout the year to the rays of the sun. But, by reason of the spheroidal figure of the terraqueous globe, the poles and polar regions enjoy the sun somewhat longer than others; and hence the Dutch who wintered in Nova Zembla in 1672 saw the sun a fortnight sooner than they ought to have done by astronomical calculations. By reason of this flatness about the poles, too, the sun not only shines for a greater space of time on these inhospitable regions, but with less obliquity in the summer-time, and hence the effect of his rays must be the greater. Now Mr Barrington considers it as an absurd supposition, that this glorious luminary should shine for six months on a cake of barren ice where there is neither animal nor vegetable. He says that the polar seas are assigned by nature as the habitation of the whales, the largest animals in the creation; but if the greatest part of the polar seas are for ever covered with an impenetrable cake of ice, these huge animals will be confined within very narrow bounds; for they cannot subsist without frequently coming to the top of the water to breathe.

Lastly, the quantity of water frozen by different degrees of cold is by no means directly in proportion to

15
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(A) See *M. Bauche's Observations on the North or Ice Sea*, where he gives an account of various attempts made to reach the pole, from which he is convinced that the sea is there open, and that the thing is practicable. M. de Pages, in his *Travels*, Vol. III. informs us, that he wished to take a voyage to the north seas, for the purpose of bringing under one view the various obstacles from the ice, which have impeded the researches of navigators in those seas; and for this purpose he was prepared to continue his voyage to as high a latitude as possible, and that he might be able to say whether any land actually exists north from the coast of Greenland. He sailed without any encouragement from his court (France) on the 16th of April 1776 from the Texel, in a Dutch vessel bound to Spitsbergen. On the 16th of May she was a little way north of 81°, the highest latitude she reached.

"Being now (says the author) less than 180 leagues from the pole, the idea of so small a distance served effectually to awaken my curiosity. Had I been able to inspire my fellow-voyagers with sentiments similar to my own, the winds and currents which at this moment carried us fast towards the pole, a region hitherto deemed inaccessible to the eye of mortals, would have been saluted with acclamations of joy. This quarter, however, is not the most eligible for such an enterprise: here the sea lying in the vicinity of those banks of ice, so frequent a little farther to the west, is much too confined. Nevertheless, when I consider the very changeable nature of the shoals under whatever form, even in their most crowded and compact state; their constant changes and concussions which break and detach them from one another, and the various expedients that may be employed for freeing the ship from confinement, as well as for obviating impending danger—I am far from viewing a voyage to the pole as a chimerical idea."

Pole.

the intensity of the cold, but likewise to the duration of it. Thus, large bodies of water are never frozen in any temperature of short duration, though shallow bodies often are. Our author observes, that as much of a given mass of water was frozen in five hours of a temperature 12° below the freezing point, as was frozen in one hour of the temperature 50° below it; and that long duration of the temperature between 20 and 32 is, with regard to the congelation of water, equivalent to intensity of cold such as is marked 0 and below 0 in Fahrenheit, but of short duration. See COLD and CONGELATION.

16
Mr Forster's argument against the possibility of reaching the pole.

On the other hand, Mr Forster, in his Observations, takes the contrary side of the question with no little vehemence. "I know (says he) that M. de Buffon, Lomonosof, and Crantz, were of opinion, that the ice found in the ocean is formed near the lands only from the fresh water and ice carried down into the sea by the many rivers in Siberia, Hudson's Bay, &c.; and therefore, when we fell in with such quantities of ice in December 1772, I expected we should soon meet with the land from whence these ice masses had been detached. But being disappointed in the discovery of this land, though we penetrated beyond the 67° twice, and once beyond 71° , south latitude, and having besides some other doubts concerning the existence of the pretended southern continent, I thought it necessary to inquire what reasons chiefly induced the above authors to form the opinion that the ice floating in the ocean must be formed near land; or that an austral land is absolutely requisite for that purpose; and having looked for their arguments, I find they amount chiefly to this: 'That the ice floating in the ocean is all fresh: that salt water does not freeze at all; or if it does, it contains briny particles. They infer from thence, that the ice in the ocean cannot be formed in the sea far from any land: there must therefore exist austral lands; because, in order to form an idea of the original of the great ice-masses agreeably to what is observed in the northern hemisphere, they find that the first point for fixing the high ice-islands is the land; and, secondly, that the great quantity of flat ice is brought down the rivers.' I have impartially and carefully considered and examined these arguments, and compared every circumstance with what we saw in the high southern latitude, and with other known facts; and will here insert the result of all my inquiries on this subject.

"First, they observe the ice floating in the ocean to yield, by melting, fresh water: which I believe to be true. However, hitherto it has by no means been generally allowed to be fresh: for Crantz says expressly, that 'the flat pieces (forming what they call the ice-fields) are salt, because they were congealed from seawater.' The ice taken up by us for watering the ship was of all kinds, and nevertheless we found it constantly fresh: Which proves, either that the principle of analogy cannot be applied indiscriminately in both hemispheres; and that one thing may be true in the northern

hemisphere which is quite otherwise in the southern, from reasons not yet known or discovered by us; or we must think that Crantz and others are mistaken, who suppose the ice floating in the ocean to be salt.

"The next remark is, That salt water does not freeze at all; or if it does, it contains briny particles. M. de Buffon tells us, 'that the sea between Nova Zembla and Spitzbergen, under the 79° north latitude, does not freeze, as it is there considerably broad: and that it is not to be apprehended to find the sea frozen not even under the pole itself; for indeed there is no example of having ever found a sea wholly frozen over, and at a considerable distance from the shores; that the only instance of a sea entirely frozen is that of the Black Sea, which is narrow and not very salt, and receives a great many rivers coming from northern regions, and bringing down ice: that this sea therefore sometimes freezes to such a degree, that its whole surface is congealed to a considerable thickness; and, if the historians are to be credited, was frozen, in the reign of the emperor Constantine Copronymus, 30 ells thick, not including 20 ells of snow which was lying on the ice. This fact, continues M. de Buffon, seems to be exaggerated: but it is true, however, that it freezes almost every winter; whilst the high seas which are 1000 leagues nearer towards the pole do not freeze; which can have no other cause than the difference in saltness, and the little quantity of ice carried out by rivers, if compared to the enormous quantity of ice which the rivers convey into the Black Sea.' M. de Buffon is not mistaken when he mentions that the Black Sea frequently freezes. Strabo informs us, that the people near the Bosphorus Cimmerius pass this sea in carts from Panticapæum to Phanagorea; and that Neoptolemus, a general of Mithridates Eupator, won a battle with his cavalry on the ice on the very spot where he gained a naval victory in the summer. Marcellinus Comes relates, that under the consulship of Vincentius and Fravita, in the year 401 after Christ, the whole surface of the Pontus was covered with ice, and that the ice in spring was carried through the Propontis, during 30 days, like mountains. Zonaras mentions the sea between Constantinople and Scutari frozen to such a degree in the reign of Constantine Copronymus, that even loaded carts passed over it. The prince Demetrius Cantemir observes, that in the year 1620-1 there happened so intense a frost, that the people walked over the ice from Constantinople to Iskodar. All these instances confirm M. de Buffon's assertion. But as this great natural historian says that the Black Sea is the only instance of a sea being entirely frozen (B), I must beg leave to dissent from him; for it is equally well attested that the Baltic is sometimes entirely frozen, according to Caspar Schutz's account. In the year 1426, the winter was so severe, that people travelled over the ice across the Baltic from Dantzic to Lubeck; and the sea was likewise passable from Denmark to Mecklenburgh: and in the year 1459 the whole Baltic was entirely frozen, so that persons travelled, both on foot and on horseback, over

Pole.

(B) In the year 860 the Mediterranean was covered with ice, so that people travelled in carts and horses across the Ionian Sea to Venice; (*Hermannus Contrañus ap. Pistor. Script. t. ii. p. 236.*) And in 1234 the Mediterranean was again thus frozen, that the Venetian merchants travelled over the ice with their merchandize to what place they chose; *Matth. Paris, p. 78.*

Pole. over ice from Denmark to the Venedick Hanſt-towns, called *Lubeck*, *Wifmar*, *Roflock*, and *Stralfund*, which had never happened before; people likewise travelled across the Baltic over ice from Reval in Eſtland to Denmark and to Sweden, and back again, without the leaſt danger (c). But, according to Sæmund Frode, even the great German Ocean between Denmark and Norway was frozen in the year 1048, ſo that the wolves frequently ran over the ice from one country to the other. The great northern ocean is likewise moſt certainly ſometimes frozen to a great diſtance from any land: for Muller relates, that in the year 1715 a Coſſack called *Markoff*, with ſome other perſons, was ſent by the Ruſſian government to explore the north ſea; but finding it next to impoſſible to make any progrefs during ſummer on account of the vaſt quantities of ice commonly filling this ocean, he at laſt determined to try the experiment during winter. He therefore took ſeveral ſledges drawn according to the cuſtom of the country by dogs, which commonly go about 80 or 100 verſts per day, 105 of which make a degree; and on March the 15th, old ſtyle, with this caravan of nine perſons, he left the ſhores of Siberia at the mouth of the river Yana, under the 71° of north latitude, and proceeded for ſeven days together northward, ſo that he had reached at leaſt the 77° or 78° north latitude, when he was ſtopped by the ice, which there began to appear in the ſhape of prodigious mountains. He climbed up to the top of ſome of theſe ice-mountains: but ſeeing from thence no land, nor any thing except ice as far as the eye could reach, and having beſides no more food for his dogs left, he thought it very neceſſary to return; which he with great difficulty performed, on April the 3d, as ſeveral of the dogs, which had periſhed for want, were employed to ſupport thoſe that remained alive. Theſe facts, I believe, will convince the unprejudiced reader, that there are other ſeas beſides the Black Sea which really do freeze in winter, and that the ice carried down the rivers could not at leaſt freeze the German Ocean between Norway and Denmark, becauſe the rivers there are ſo ſmall, and bear a very inconfiderable proportion to the immenſe ocean, which, according to experiments made by Mr Wilke, is very ſalt, though near the land, in the Swediſh harbour of Landſerona.

“ Now, if ſix or ſeven degrees of latitude, containing from 360 to 420 ſea-miles, are not to be reckoned a great diſtance from the land, I do not know in what manner to argue, becauſe no diſtance whatſoever will be reckoned far from any land. Nay, if the Coſſack Markoff, being mounted on one of the higheſt ice-mountains, may be allowed to ſee at leaſt to the diſtance of 20 leagues, the extent alluded to above muſt then be increaſed to 480 Engliſh ſea-miles; which certainly is very conſiderable, and makes it more than probable that the ocean is frozen in winter, in high northern latitudes, even as far as the pole. Beſides, it invalidates the argument which theſe gentlemen wiſh to infer from thence, *that the ocean does not freeze in high latitudes, eſpecially where there is a conſiderably broad ſea*; for we have ſhown inſtances to the contrary.

“ But M. de Buffon ſpeaks of ice carried down the rivers into the northern ocean, and forming there theſe immenſe quantities of ice. ‘ And in caſe, ſays he, we would ſuppoſe, againſt all probability, that at the pole it could be ſo cold as to congeal the ſurface of the ſea, it would remain equally incomprehenſible how theſe enormous floating ice-maſſes could be formed, if they had not land for a point to fix on, and from whence they are ſeized by the heat of the ſun. The two ſhips, which the India Company ſent in 1739 upon the diſcovery of the auſtral lands, found ice in 47° or 48° ſouth latitude, but at no great diſtance from land; which they diſcovered, without being able to approach it. This ice, therefore, muſt have come from the interior parts of the lands near the ſouth pole; and we muſt conjecture, that it follows the courſe of ſeveral large rivers, waſhing theſe unknown lands, in the ſame manner as the rivers Oby, the Yenifea, and the other great rivers which fall into the northern ſea, carry the ice-maſſes, which ſtop up the ſtraits of Waigats for the greater part of the year, and render the Tartarian ſea inacceſſible upon this courſe.’ Before we can allow the analogy between the rivers Oby, Yenifea, and the reſt which fall into the northern ocean, and thoſe coming from the interior parts of the auſtral lands, let us compare the ſituation of both countries, ſuppoſing the auſtral lands really to exiſt. The Oby, Yenifea, and the reſt of the Siberian rivers, falling down into the northern

(c) In 1296 the Baltic was frozen from Gothland to Sweden: (*Incerti auſtoris Annales Denor. in Weſtphaliæ monument. Cimbr. t. i. p. 1392.*)

In 1306 the Baltic was, during fourteen weeks, covered with ice between all the Daniſh and Swediſh iſlands. (*Ludwig. reliquia, MSS. t. ix. p. 170.*)

In 1323 there was a road for foot-paſſengers and horſemen over the ice on the Baltic during ſix weeks. (*id. ibid.*)

In 1349, people walking over the ice from Stralfund to Denmark. (*Incerti auſt. cit. ap. Ludwig. t. ix. p. 181.*)

In 1408 the whole ſea between Gothland and Oeland, and likewise between Roſtock and Gezoer, was frozen. (*id. ibid.*)

In 1423 the ice bore riding from Pruſſia to Lubec. (*Crantzii Vandal. l. x. c. 40.*) The whole ſea was covered with ice from Mecklenburg to Denmark. (*Incert. auſt. ap. Ludwig. t. ix. p. 125.*)

In 1461 (ſays Nicol. Marſchallus in *Annal. Herul. ap. Weſtphal. t. i. p. 261.*) Tanta erat hyems, ut concreto gelu oceano pluſtris millia paſſuum ſupra CCC merces ad ultimam Thylen (*Iceland*) et Orcades veherentur e Germania tota pene bruna.

In 1545 the ſea between Roſtock and Denmark, and likewise between Fionia and Sealand, was thus frozen, that the people travelled over the ice on foot, with ſledges to which horſes and oxen were put. (*Anonym. ap. Ludwig. t. ix. p. 176.*)

In 1294 the Cattegat or ſea between Norway and Denmark was frozen; that from Oxſlo in Norway, they could travel on it to Jutland. (*Strelow Chron. Juthiland, p. 148.*)

Pole northern ocean, have their sources in 48° and 50° north latitude, where the climate is mild and capable of producing corn of all kinds. All the rivers of this great continent increasing, these great rivers have likewise their sources in mild and temperate climates, and the main direction of their course is from south to north; and the coast of the northern ocean, not reckoning its sinuosities, runs in general west and east. The small rivers which are formed in high latitudes have, properly speaking, no sources, no springs, but carry off only the waters generated by the melting of snow in spring, and by the fall of rain in the short summer, and are for the greatest part dry in autumn. And the reason of this phenomenon is obvious, after considering the constitution of the earth in those high northern climates. At Yakutsk, in about 62° north latitude, the soil is eternally frozen, even in the height of summer, at the depth of three feet from the surface. In the years 1685 and 1686, an attempt was made to dig a well; and a man, by great and indefatigable labour, continued during two summer-seasons, and succeeded so far in this laborious task, that he at last reached the depth of 91 feet; but the whole earth at this depth was frozen, and he met with no water; which forced him to desist from so fruitless an attempt. And it is easy to infer from hence how impossible it is that springs should be formed in the womb of an eternally frozen soil.

17
Of the
freezing
of salt-
water.

“The argument, therefore, is now reduced to this, *That salt water does not freeze at all; or, if it does, the ice contains briny particles.* But we have already produced numberless instances, that the sea does freeze; nay, Crantz allows, *that the flat pieces of ice are salt, because they were congealed from sea-water.* We beg leave to add a few decisive facts relative to the freezing of the sea. Barentz observes in the year 1596, September the 16th, the sea froze two fingers thick, and next night the ice was as thick again. This happened in the midst of September; what effect then must the intense frost of a night in January not produce? When Captain James wintered in Charleton’s Isle, the sea froze in the middle of December 1631. It remains, therefore, only to examine, whether the ice formed in the sea must necessarily contain briny particles. And here I find myself in a very disagreeable dilemma; for during the intense frost of the winter in 1776, two sets of experiments were made on the freezing of sea-water, and published, contradicting one another almost in every material point. The one by Mr Edward Nairne F. R. S. an ingenious and accurate observer; the other by Dr Higgins, who reads lectures on chemistry and natural philosophy, and consequently must be supposed to be well acquainted with the subject. I will therefore still venture to consider the question as undecided by these experiments, and content myself with making a few observations on them: but previously I beg leave to make this general remark, that those who are well acquainted with mechanics, chemistry, natural philosophy, and the various arts which require a nice observation of minute circumstances, need not be informed, that an experiment or machine succeeds often very well when made

upon a smaller scale, but will not answer if undertaken at large; and, *vice versa*, machines and experiments executed upon a small scale will not produce the effect which they certainly have when made in a more enlarged manner. A few years ago an experiment made on the dyeing of scarlet, did not succeed when undertaken on a small scale, whereas it produced the desired effect when tried at a dyer’s house with the large apparatus; and it evidently confirms the above assertion, which I think I have a right to apply to the freezing of salt-water. It is therefore probable, that the ice formed in the ocean at large, in a higher latitude, and in a more intense degree of cold, whereof we have no idea here, may become solid, and free from any briny particles, though a few experiments made by Dr Higgins, in his house, on the freezing of salt-water, produced only a loose spongy ice filled with briny particles.

“The ice formed of sea-water by Mr Nairne was very hard, 3½ inches long, and 2 inches in diameter: it follows from thence, that the washing the outside of this ice in fresh water, could not affect the inside of a hard piece of ice. This ice when melted yielded fresh water, which was specifically lighter than water which was a mixture of rain and snow-water, and next in lightness to distilled water. Had the ice thus obtained not been fresh, the residuum of the sea-water, after this ice had been taken out, could not have been specifically heavier than sea-water, which, however, was the case in Mr Nairne’s experiment. It seems, therefore, in my opinion, evident from hence, that salt-water does freeze, and has no other briny particles than what adhere to its outside. All this perfectly agrees with the curious fact related by Mr Adanson (D), who had brought to France two bottles of sea-water, taken up in different parts of the ocean, in order to examine it, and to compare its saltness, when more at leisure; but both the bottles containing the salt-water were burst by being frozen, and the water produced from melting the ice proved perfectly fresh. This fact is so fairly stated, and so very natural, that I cannot conceive it is necessary to suppose, without the least foundation for it, *that the bottles were changed, or that Mr Adanson does not mention the circumstance by which the sea-water was thus altered upon its being dissolved*: for as he expressly observes the bottles to have been burst, it is obvious that the concentrated briny parts ran out, and were entirely drained from the ice, which was formed of the fresh water only.

“The ice formed by Dr Higgins from sea-water, consisted of thin laminae, adhering to each other weakly. Dr Higgins took out the frozen ice from the vessels wherein he exposed the sea-water, and continued to do so till the remaining concentrated sea-water began to form crystals of sea-salt. Both these experiments, therefore, by no means prove what the Doctor intended to infer from thence; for it was wrong to take out such ice, which only consisted of thin laminae, adhering to each other weakly. Had he waited with patience, he would have obtained a hard ice as well as Mr Nairne, which, by a more perfect congelation, would have excluded the

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the briny particles intercepted between the *thin laminae*, adhering to each other weakly; and would have connected the laminae, by others formed by fresh water. The Doctor found afterwards, it is true, thicker and somewhat more solid ice: but the sea-water had already been so much concentrated by repeated congelations, that it is no wonder the ice formed in it became at last brackish: it should seem, then, that no conclusive arguments can be drawn from these experiments.

“There are two other objections against the formation of the ice in the great ocean. The *first* is taken from the immense bulk and size of the ice masses formed in the ocean, which is *the deepest mass of water we know of*. But it has been experimentally proved, that in the midst of summer, in the latitudes of 55° , $55^{\circ} 26'$, and 64° south, at 100 fathoms depth, the thermometer stood at 34° , $34^{\circ} \frac{1}{2}$ and 32° ; and that in all instances, the difference between the temperature at top and 100 fathoms depth never exceeded four degrees of Fahrenheit's thermometer, or that the temperature of the air did not differ five degrees from that of the ocean at 100 fathom deep. If we now add to this, that beyond the 71° south the temperature of the air and ocean must be still colder, and that the rigours of an antarctic winter are certainly more than sufficient to cool the ocean to $28^{\circ} \frac{1}{2}$, which is requisite for congealing the aqueous particles in it; if we moreover consider, that these severe frosts are continued during six or eight months of the year, we may easily conceive that there is time enough to congeal large and extensive masses of ice. But it is likewise certain, that there is more than one way by which those immense ice masses are formed. We suppose very justly, that the ocean does freeze, having produced so many instances of it; we allow likewise, that the ice thus formed in a calm, perhaps does not exceed three or four yards in thickness; a storm probably often breaks such an ice-field, which Crantz allows to be 200 leagues one way and 80 the other; the pressure of the broken fragments against one another frequently sets one upon the other piece, and they freeze in that manner together; several such double pieces, thrown by another pressure upon one another, form at last large masses of miles extent, and of 20, 40, 60, and more fathoms thickness, or of a great bulk or height. Martens, in his description of Spitzbergen, remarks, that the pieces of ice cause so great a noise by their shock, that the navigators in those regions can only with difficulty hear the words of those that speak; and as the ice-pieces are thrown one upon another, ice-mountains are formed by it. And I observed very frequently, in the years 1772 and 1773, when we were among the ice, masses which had the most evident marks of such a formation, being composed of strata of some feet in thickness. This is in some measure confirmed by the state in which the Cossack Markoff found the ice at the distance of 420 miles north from the Siberian coasts. The high masses were not found formed, as is suspected in the *Second supplement to the probability of reaching the north pole*, p. 143-145, near the land, under the high cliffs, but far out at sea; and when these ice mountains were climbed by Markoff, nothing but ice, and no vestiges of land, appeared as far as the eye could reach. The high climates near the poles are likewise subject to heavy falls of snow,

of several yards in thickness, which grow more and more compact, and by thaws and rain are formed into solid ice, which increase the stupendous size of the floating ice mountains.

“The *second* objection against the freezing of the ocean into such ice as is found floating in it, is taken from the *opacity* of ice formed in salt water; because the largest masses are commonly transparent like crystal, with a fine blue tint, caused by the reflection of the sea. This argument is very specious, and might be deemed unanswerable by those who are not used to cold winters and their effects. But whosoever has spent several winters in countries which are subject to intense frosts, will find nothing extraordinary or difficult in this argument: for it is a well-known fact in cold countries, that the ice which covers their lakes and rivers is often opaque, especially when the frost sets in, accompanied by a fall of snow; for, in those instances, the ice looks, before it hardens, like a dough or paste, and when congealed it is opaque and white; however, in spring, a rain and the thaw, followed by frosty nights, change the opacity and colour of the ice, and make it quite transparent and colourless like a crystal: but, in case the thaw continues, and it ceases entirely to freeze, the same transparent ice becomes soft and porous, and turns again entirely opaque. This I believe may be applicable to the ice seen by us in the ocean. The field-ice was commonly opaque; some of the large masses, probably drenched by rain, and frozen again, were transparent and pellucid; but the small fragments of loose ice, formed by the decay of the large masses, and soaked by long-continued rains, we found to be porous, soft, and opaque.

“It is likewise urged as an argument against the formation of ice in the ocean, that it always requires land, in order to have a point upon which it may be fixed. First, I observe, that in Mr Nairne's experiments, the ice was generated on the surface, and was seen shooting crystals downwards: which evidently evinces, in my opinion, that ice is there formed or generated where the intensest cold is; as the air sooner cools the surface than the depth of the ocean, the ice shoots naturally downwards, and cools the ocean more and more, by which it is prepared for further congelation. I suppose, however, that this happens always during calms, which are not uncommon in high latitudes, as we experienced in the late expedition. Nor does land seem absolutely necessary in order to fix the ice; for this may be done with as much ease and propriety to the large ice mountains which remain undissolved floating in the ocean in high latitudes; or it may, perhaps, not be improper to suppose, that the whole polar region, from 80° and upwards, in the southern hemisphere, remains a solid ice for several years together, to which yearly a new circle of ice is added, and of which, however, part is broken off by the winds and the return of the mild season. Wherever the ice floats in large masses, and sometimes in compact bodies formed of an infinite number of small pieces, there it is by no means difficult to freeze the whole into one piece; for amongst the ice the wind has not a power of raising high and great waves. This circumstance was not entirely unknown to the ancients; and it is probable they acquired this information from the natives

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of ancient Gaul, and from the Britons and other northern nations, who sometimes undertook long voyages. The northern ocean was called by the ancients the *frozen*, the *dead*, the *lazy*, and *immoveable sea*: sometimes they gave it the name *mare cronium*, the concrete sea, and *norimarusa*, the dead sea. And, what is very remarkable, in all the northern cold countries the frost sometimes is so intense, that all the waters become suddenly coagulated into a kind of paste or dough, and thus at once congeal."

19
Observations on
Mr Forster's reasoning.

On this reasoning of Mr Forster's, however, we must observe, that it cannot possibly invalidate any fact which Mr Barrington has advanced. The best concerted and most plausible theory in the world must yield to experience; for this is in fact what must judge all theories. Now, from what we have already related, it is demonstrated, that in the space between the mouths of the rivers Piasida and Chatanga more ice must be formed, and more intense colds generated, than in any other part of the world; consequently, for a considerable space both on the east and west side of that, the sea must be more full of ice than anywhere else. Now, between these two rivers there is the promontory of Taimura, which runs out to the latitude of 78°, or near it, and which of necessity must obstruct the dispersion of the ice; and that it actually does so is in some degree probable, because in one of the Russian voyages above-mentioned the eastern mouth of the Lena was quite free, when the western ones were entirely choaked up with ice. Now the mouth of the Yana lies several degrees to the eastward of the Lena: consequently, when the ice comes eastward from the Cape of Taimura, it must necessarily fill all that sea to the latitude of 78° and upwards; but the Cossack Markoff, if he proceeded directly north, could not be farther than the promontory of Taimura, and consequently still enveloped among the ice. Besides, we are certain, that the sea in 78° is not at all frozen into a solid cake in some places, since Lord Mulgrave, in 1773, reached 81°. Mr Forster's argument, therefore, either proves nothing, or it proves too much. If it proves, that about the middle of the eastern continent the cold is so intense that a sufficient quantity of ice is formed to obstruct the navigation for several hundred miles round, this proves nothing; because we knew before that this must be the case: But if it proves, that the sea must be un-navigable by reason of ice all round the globe at 78° N. L. this is too much; because we certainly know, that in 1773 Lord Mulgrave reached the latitude of 81°. However, though it should be allowed that the sea is quite clear all the way to the pole, it must be a very great uncertainty whether any ship could by that way reach the East Indies; because we know that it must sail down between the continents of Asia and America, through that strait whose mouth must often be blocked up with ice driving eastward along the continent of Asia.

The south pole is still more inaccessible than the north pole; for the ice is found in much lower southern than northern latitudes. Upon this subject M. Pages speaks thus: "Having in former voyages (says he) visited many parts of the terraqueous globe in different latitudes, I had opportunities of acquiring a considerable knowledge of climate in the torrid as well as in the temperate divisions of the earth. In a subsequent voyage

I made it my business to be equally well informed respecting the reputed inhospitable genius of the South Seas; and upon my return from that expedition I entertained not the smallest doubt that there exists a peculiar and perpetual rigour in the southern hemisphere." (See his *Travels round the World*, v. iii. translated from the French, and printed at London, 1792, for Murray.) This superior degree of cold has by many been supposed to proceed from a greater quantity of land about the south than the north pole*; and the notion of a vast continent in these regions prevailed almost universally, inasmuch that many have fought for it, but hitherto in vain. See the articles *Cook's Discoveries*, n° 38—49. and n° 68. and 69. *SOUTH-Sea*, and *TERRA Australis*.

Magnetic POLE. See MAGNET, MAGNETISM, § 4. p. 432. and p. 441. and VARIATION.

North POLE. See POLE.

POLE-Axe, a sort of hatchet nearly resembling a battle-axe, having an handle about 15 inches in length, and being furnished with a sharp point or claw, bending downwards from the back of its head; the blade whereof is formed like that of any other hatchet. It is principally employed in sea-fights to cut away and destroy the rigging of any adversary who endeavours to board.

Pole-axes are also said to have been successfully used on some occasions in boarding an enemy, whose sides were above those of the boarder. This is executed by detaching several gangs to enter at different parts of the ship's length, at which time the pole-axes are forcibly driven into her side, one above another, so as to form a sort of scaling-ladders.

POLE Cat. See MUSTELA.

POLE Star. See ASTRONOMY, n° 3 17. and 39.

POLEIN, in English antiquity, is a sort of shoe, sharp or picked at the point. This fashion took its rise in the time of king William Rufus; and the picks were so long, that they were tied up to the knees with silver or golden chains. They were forbidden by stat. an. 4 Edw. IV. cap. 7. *Tunc fluxus crinium, tunc luxus vestium, tunc usus calceorum cum arcuatis aculeis inventus est*. Malmesb. in Will. ii.

POLEMARCHUS was a magistrate at Athens, who had under his care all the strangers and sojourners in the city, over whom he had the same authority that the archon had over the citizens. It was his duty to offer a solemn sacrifice to Enyalus (said to be the same with Mars, though others will have it that he was only one of his attendants), and another to Diana, surnamed *Αρπύρεια*, in honour of the famous patriot Harmodius. It was also his business to take care that the children of those that had lost their lives in the service of their country should be provided for out of the public treasury.

POLEMICAL, in matters of literature, an appellation given to books of controversy, especially those in divinity.

POLEMO, who succeeded Xenocrates in the direction of the academy, was an Athenian of distinguished birth, and in the earlier part of his life a man of loose morals. The manner in which he was reclaimed from the pursuit of infamous pleasures, and brought under the discipline of philosophy, affords a memorable example of the power of eloquence employed in the cause of virtue. His history is thus related by Dr Enfield: "As he was, one morning about the rising of the sun, returning home from the revels of the night,

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Polemo.

* See A-
MERICA,
n° 3—5,
and Cook's
Discoveries,
n° 38, &c.

Potter's
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Polenbourg.

night, clad in a loose robe, crowned with garlands, strongly perfumed, and intoxicated with wine, he passed by the school of Xenocrates, and saw him surrounded with his disciples. Unable to resist so fortunate an opportunity of indulging his sportive humour, he rushed without ceremony into the school, and took his place among the philosophers. The whole assembly was astonished at this rude and indecent intrusion, and all but Xenocrates discovered signs of resentment. Xenocrates, however, preserved the perfect command of his countenance; and with great presence of mind turned his discourse from the subject on which he was treating to the topics of temperance and modesty, which he recommended with such strength of argument, and energy of language, that Polemo was constrained to yield to the force of conviction. Instead of turning the philosopher and his doctrine to ridicule, as he at first intended, he became sensible of the folly of his former conduct; was heartily ashamed of the contemptible figure which he had made in so respectable an assembly; took his garland from his head; concealed his naked arm under his cloak; assumed a sedate and thoughtful aspect; and, in short, resolved from that hour to relinquish his licentious pleasures, and devote himself to the pursuit of wisdom. Thus was this young man, by the powerful energy of truth and eloquence, in an instant converted from an infamous libertine to a respectable philosopher. In such a sudden change of character it is difficult to avoid passing from one extreme to another. Polemo, after his reformation, in order to brace up his mind to the tone of rigid virtue, constantly practised the severest austerity and most hardy fortitude. From the thirtieth year of his age to his death he drank nothing but water. When he suffered violent pain, he showed no external sign of anguish. In order to preserve his mind undisturbed by passion, he habituated himself to speak in an uniform tone of voice, without elevation or depression. The austerity of his manners was, however, tempered with urbanity and generosity. He was fond of solitude, and passed much of his time in a garden near his school. He died, at an advanced age, of a consumption. Of his tenets little is said by the ancients, because he strictly adhered to the doctrine of Plato."

POLEMONIUM, GREEK VALERIAN, or *Jacob's Ladder*: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 29th order, *Campanacea*. The corolla is quinquepartite; the stamina inserted into scales, which close the bottom of the corolla; the stigma is trifid: the capsule bilocular superior. There are two species, of which the most remarkable is the cœruleum, with an empalement longer than the flower. It grows naturally in some places of England: however, its beauty has obtained it a place in the gardens. There are three varieties; one with a white, another with a blue, and another with a variegated flower; also a kind with variegated leaves. They are easily propagated by seeds; but that kind with variegated leaves is preserved by parting its roots, because the plants raised from seeds would be apt to degenerate and become plain.

POLEMOSCOPE, in optics, the same with **OPERA-GLASS**. See **DIOPTRICS**, p. 37. col. 1. par. 3.

POLENBURG (Cornelius), an excellent painter of little landscapes and figures, was born at Utrecht in 1586, and educated under Blomaert, whom he soon

quitted to travel into Italy; and studied for a long time in Rome and Florence, where he formed a style entirely new, which, though preferable to the Flemish, is unlike any Italian, except in his having adorned his landscapes with ruins. There is a varnished smoothness and finishing in his pictures, that render them always pleasing, though simple and too nearly resembling one another. The Roman cardinals were charmed with the neatness of his works, as was also the great duke; but could not retain him. He returned to Utrecht, and pleased Rubens, who had several of his performances. King Charles I. invited him to London, where he generally painted the figures in Steenwyck's perspectives: but the king could not prevail on him to fix here; for after staying only four years, and being handsomely rewarded by his majesty for several pieces which he performed for him, he returned to Utrecht, and died there at the age of 74. His works are very scarce and valuable.

POLERON, one of the Banda or nutmeg islands in the East Indies. This was one of those spice islands which put themselves under the protection of the English, and voluntarily acknowledged James I. king of England for their sovereign; for which reason the natives of this and the rest of the islands were murdered or driven thence by the Dutch, together with the English.

POLESIA, a province of Poland, bounded by Polachio and Proper Lithuania on the north, and by Volhinia on the south. It is one of the palatinates of Lithuania, and is commonly called *Brescia*, and its capital is of this name. It is full of forests and lakes.

POLESINO-DE-ROVIGO, a province of Italy, in the republic of Venice, lying to the north of the river Po; and bounded on that side by the Paduan, on the south by the Ferrarese, on the east by Degado, and on the west by the Veronese. It is 45 miles in length, and 17 in breadth, and is a fertile country. Rovigo is the capital.

POLETÆ were ten magistrates of Athens, who, with three that had the management of money allowed for public shows, were empowered to let out the tribute-money and other public revenues, and to sell confiscated estates; all which bargains were ratified by their president, or in his name. They were by their office also bound to convict such as had not paid the tribute called *ΜΕΤΟΙΚΙΑ*, and sell them in the market by auction. The market where these wretches were sold was called *ΠΩΛΗΘΗΡΙΟΝ ΤΩ ΜΕΤΟΙΚΩ*.

POLIANTHES, the **TUBEROSE**: A genus of the monogynia order, belonging to the hexandria class of plants; and in the natural method ranking under the 10th order, *Coronaria*. The corolla is funnel-shaped, incurved, and equal; the filaments are inserted into the throat of the corolla; in the bottom of which the germen is situated. There is but one species, consisting of some varieties; all of which being exotics of tender quality, require aid of artificial heat, under shelter of frames and glasses, &c. to bring them to flower in perfection in this country. The polianthes, or tuberose, hath an oblong, bulb-like, tuberous, white root; crowned with a few long very narrow leaves; amidst them an upright, straight, firm stem, three or four feet high, terminated by a long spike of large white flowers arranged alternately. The varieties are the common tu-
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Polianthes.

berose, with single flowers,—double-flowered,—dwarf-stalked,—variegated-leaved. They all flower here in June, July, and August: the flowers are funnel or bell shaped; garnish the upper part of the stem in a long spike, consisting of from 10 to 20 or more separate in alternate arrangements, the lower flowers opening first, which are succeeded by those above, in regular order, making in the whole a most beautiful appearance, highly enriched with a most fragrant odour. The common single-flowered tuberose is the sort the most commonly cultivated, as it generally blows the most freely, and possesses the finest fragrance. The double-flowered kind also highly merits culture, as when it blows fair it makes a singularly fine appearance. The dwarf and the variegated kinds are inferior to the other two, but may be cultivated for variety.

All the varieties being exotics from warm countries, although they are made to flower in great perfection in our gardens by assistance of hot-beds, they will not prosper in the open ground, and do not increase freely in England; so that a supply of the roots is imported hither annually from Genoa, and other parts of Italy, by most of the eminent nursery and seedsmen, and the Italian warehouse-keepers; generally arriving in February or March, time enough for the ensuing summer's bloom; and are sold commonly at the rate of twelve or fifteen shillings per hundred, being careful always to procure as large roots as possible, for on this depends the success of having a complete blow. They, requiring artificial heat to blow them in this country, are planted in pots, and plunged in a hot-bed, under a deep frame furnished with glass lights; or placed in a hot-house, where they may be blowed to great perfection with little trouble. The principal season for planting them is March and April: observing, however, that in order to continue a long succession of the bloom, it is proper to make two or three different plantings, at about a month interval; one in March, another in April, and a third the beginning of May, whereby the blow may be continued from June until September; observing, as above-mentioned, they may be flowered either by aid of a common dung or bark hot-bed, or in a hot-house.

With respect to the propagation of these plants, it is principally by offsets of the roots. The blowing roots that are brought annually from abroad for sale are often furnished with offsets, which ought to be separated previous to planting. Those also that are planted here in our gardens frequently furnish offsets fit for separation in autumn when the leaves decay: they must then be preserved in sand all winter in a dry sheltered place; and in the beginning of March, plant them either in a bed of light dry earth in the full ground; or, to forward them as much as possible, allow them a moderate hot-bed; and in either method indulge them with a shelter in cold weather, either of a frame and lights, or arched with hoops and occasionally matted; but let them enjoy the full air in all mild weather, giving also plenty of water in dry weather during the season of their growth in spring and summer. Thus let them grow till their leaves again decay in autumn: then take them up, clean them from earth, and lay them in sand till spring; at which time such roots as are large enough to blow may be planted and managed as already directed, and the smaller roots planted again in a nursery-bed, to have another year's growth; after-

wards plant them for flowering. The Egyptians put the flowers of tuberose into sweet oil; and by this means give it a most excellent flavour, scarce inferior to oil of jasmine.

POLICANDRO, a small island in the Archipelago, seated between Milo and Morgo. It has no harbour, but has a town about three miles from the shore near a huge rock. It is a ragged stony island, but yields as much corn as is sufficient for the inhabitants, who consist of about 120 Greek families, all Christians. The only commodity is cotton; of which they make napkins, a dozen of which are sold for a crown. E. Long. 35. 25. N. Lat. 36. 36.

POLICASTRO, an episcopal town of Italy, in the kingdom of Naples, and in the Hither Principato; but now almost in ruins, for which reason the bishop resides in another town. E. Long. 15. 46. N. Lat. 40. 26.

POLICY, or POLITY, in matters of government. See POLITY.

POLICY of Insurance, or Assurance, of ships, is a contract or convention, whereby a person takes upon himself the risks of a sea-voyage; obliging himself to make good the losses and damages that may befall the vessel, its equipage, tackle, victualling, lading, &c. either from tempests, shipwrecks, pirates, fire, war, reprisals, in part or in whole; in consideration of a certain sum of seven, eight, or ten *per cent.* more or less according to the risk run; which sum is paid down to the assurer by the assured upon his signing the policy. See INSURANCE.

POLIDORO DA CARAVAGGIO, an eminent painter, born at Caravaggio in the Milanese in 1492. He went young to Rome, where he worked as a labourer in preparing stucco for the painters; and was so animated by seeing them at work in the Vatican, that he solicited some of them to teach him the rules of designing. He attached himself particularly to Maturino, a young Florentine; and a similarity in talents and taste producing a disinterested affection, they associated like brothers, laboured together, and lived on one common purse, until the death of Maturino. He understood and practised the *chiaro-scuro* in a degree superior to any in the Roman school; and finished an incredible number of pictures both in fresco and in oil, few of the public buildings at Rome being without some of his paintings. Being obliged to fly from Rome when it was stormed and pillaged, he retired to Messina, where he obtained a large sum of money with great reputation, by painting the triumphal arches for the reception of Charles V. after his victory at Tunis: and when he was preparing to return to Rome, he was murdered, for the sake of his riches, by his Sicilian valet with other assassins, in the year 1543.

POLIFOLIA. See ANDROMEDA.

POLIGNAC (Melchier de), an excellent French genius and a cardinal, was born of an ancient and noble family at Puy, the capital of Velay, in 1662. He was sent by Louis XIV. ambassador extraordinary to Poland, where, on the death of Sobieski, he formed a project of procuring the election of the prince of Conti. But failing, he returned home under some disgrace; but when restored to favour, he was sent to Rome as auditor of the Rota. He was plenipotentiary during the congress at Utrecht, at which time Clement I. created him a cardinal; and upon the accession of Louis XV. he was appointed to reside at Rome as minister of France.

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Polignac.

Polisher France. He remained there till the year 1732, and died in the year 1741. He left behind him a MS. poem entitled *Anti-Lucretius, seu De Deo et Natura*; the plan of which he is said to have formed in Holland in a conversation with Mr Bayle. This celebrated poem was first published in the year 1749, and has since been several times printed in other countries besides France. He had been received into the French Academy in 1704, into the Academy of Sciences in 1715, into that of the Belles Lettres in 1717: and he would have been an ornament to any society, having all the accomplishments of a man of parts and learning.

POLISHER, or **BURNISHER**, among mechanics, an instrument for polishing and burnishing things proper to take a polish. The gilders use an iron-polisher to prepare their metals before gilding, and the blood-stone to give them the bright polish after gilding.

The polishers, among cutlers, are a kind of wooden wheels made of walnut-tree, about an inch thick, and of a diameter at pleasure, which are turned round by a great wheel; upon these they smooth and polish their work with emery and putty.

The polishers for glasses consist of two pieces of wood; the one flat, covered with old hat; the other long and half-round, fastened on the former, whose edge it exceeds on both sides by some inches, which serves the workmen to take hold of, and to work backwards and forwards by.

The polishers used by spectacle-makers are pieces of wood a foot long, seven or eight inches broad, and an inch and a half thick, covered with old beaver hat, whereon they polish the shell and horn frames their spectacle-glasses are to be set in.

POLISHING, in general, the operation of giving a gloss or lustre to certain substances, as metals, glass, marble, &c.

The operation of polishing optic-glasses, after being properly ground, is one of the most difficult points of the whole process. See **TELESCOPE**.

POLITENESS means elegance of manners or good breeding: Lord Chesterfield calls it the art of pleasing. It has also been called an artificial good nature; and indeed good nature is the foundation of true politeness; without which art will make but a very indifferent figure, and will generally defeat its own ends. "Where compliance and assent, caution and candour, says an elegant essayist*, arise from a natural tenderness of disposition and softness of nature, as they sometimes do, they are almost amiable and certainly excusable; but as the effects of artifice, they must be despised. The persons who possess them are, indeed, often themselves dupes of their own deceit, when they imagine others are deluded by it. For excessive art always betrays itself; and many, who do not openly take notice of the deceiver, from motives of delicacy and tenderness for his character, secretly deride and warmly resent his ineffectual subtlety."

* *Dr Knox.* "True politeness (says another author†) is that continual attention which humanity inspires us with, both to please others, and to avoid giving them offence. The surly plain-dealer exclaims loudly against this virtue, and prefers his own shocking bluntness and Gothic freedom. The courtier and fawning flatterer, on the contrary, substitute in its place insipid compliments, cringings, and a jargon of unmeaning sentences. The one blames polite-

ness, because he takes it for a vice; and the other is the occasion of this, because that which he practises is really so."

Both these characters act from motives equally absurd, though not equally criminal. The conduct of the artful flatterer is guided by self-love, while that of the plain-dealer is the effect of ignorance; for nothing is more certain, than that the desire of pleasing is founded on the mutual wants and the mutual wishes of mankind; on the pleasure which we wish to derive from society, and the character which we wish to acquire. Men having discovered that it was necessary and agreeable to unite for their common interests, they have made laws to repress the wicked, they have settled the duties of social life, and connected the idea of respectability with the practice of those duties; and after having prescribed the regulations necessary to their common safety, they have endeavoured to render their commerce with one another agreeable, by establishing the rules of politeness and good breeding. Indeed, as an elegant author already quoted remarks, the philosopher who, in the austerity of his virtue, should condemn the art of pleasing as unworthy cultivation, would deserve little attention from mankind, and might be dismissed to his solitary tub, like his brother Diogenes. It is the dictate of humanity, that we should endeavour to render ourselves agreeable to those in whose company we are destined to travel in the journey of life. It is our interest, it is the source of perpetual satisfaction; it is one of our most important duties as men, and particularly required in the professor of Christianity."

It is needless to particularize the motives which have induced men to practise the agreeable virtues; for, from whatever source the desire of pleasing proceeds, it has always increased in proportion to the general civilization of mankind. In a rude state of society, pleasure is limited in its sources and in its operation. When the wants of mankind, and the means of attaining them, are few, personal application is necessary to gratify them, and it is generally sufficient; by which means an individual becomes more independent than can possibly be the case in civilized life, and of course less disposed to give or receive assistance. Confined to the solitary wish of furnishing means for his own happiness, he is little intent on the pleasures of conversation and society. His desire of communication is equal to the extent of his knowledge. But as soon as the natural wants of life are filled up, we find unoccupied time, and we labour hard to make it pass in an agreeable manner. It is then we perceive the advantage of possessing a rational nature, and the delights of mutual intercourse. When we consider society in that state of perfection which enables a great part of the members of it to pursue at leisure the pleasures of conversation, we should expect, both from the ease of acquitting ourselves to the satisfaction of our associates, and from the advantages arising from this conduct, that the art of pleasing might be reduced to a few plain and simple rules, and that these might be derived from a slight attention to general manners.

The art of pleasing, in our intercourse with mankind, is indeed so simple, that it requires nothing more than the constant desire to please in all our words and actions; and the practice of it can neither wound a man's self-love, nor be prejudicial to his interest in any possible situation.

Politeness.

But though this be certain, it is doubtless less attended to, than in reason it ought to be. Each particular man is so zealous to promote his own ends or his own pleasure, as to forget that his neighbour has claims equal to his own; that every man that enters into company gives up for the time a great many of his peculiar rights; and that he then forms part of an association, met together not for the particular gratification of any one, but for the purpose of general satisfaction. See BREEDING, CONVERSATION, and *Good MANNERS*.

The qualities essential in the art of pleasing, are *virtue, knowledge, and manners*. All the virtues which form a good and respectable character in a moral sense are essential to the art of pleasing. This must be an established principle, because it depends on the wants and mutual relations of society. In all affairs of common business, we delight in transacting with men in whom we can place confidence, and in whom we find integrity; but truth is so naturally pleasing, and the common affairs of life are so interwoven with social intercourse, that we derive abundantly more satisfaction from an honest character than from specious manners. "Should you be suspected (says Chesterfield) of injustice, malignity, perfidy, lying, &c. all the parts and knowledge of the world will never procure you esteem, friendship, and respect."

The first of virtues in our commerce with the world, and the chief in giving pleasure to those with whom we associate, is inviolable sincerity of heart. We can never be too punctual in the most scrupulous tenderness to our moral character in this respect, nor too nicely affected in preserving our integrity.

The peculiar modes, even of the fashionable world, which are founded in dissimulation, and which on this account have induced several to recommend the practice, would not prevent a man of the highest integrity from being acceptable in the very best company. Acknowledged sincerity gives the same ornament to character that modesty does to manners. It would abundantly atone for the want of ridiculous ceremony, or false and unmeaning professions; and it would in no respect diminish the lustre of a noble air, or the perfection of an elegant address.

If integrity be the foundation of that character which is most generally acceptable, or which, in other words, possesses the power of pleasing in the highest degree, humanity and modesty are its highest ornaments.

The whole art of pleasing, as far as the virtues are concerned, may be derived from the one or other of these sources. Humanity comprehends the display of every thing amiable to others; modesty removes or suppresses every thing offensive in ourselves.

This modesty, however, is not inconsistent with firmness and dignity of character: it arises rather from the knowledge of our imperfection compared with a certain standard, than from conscious ignorance of what we ought to know. We must therefore distinguish between this modesty and what the French call *mauvaise honte*. The one is the unaffected and unassuming principle which leads us to give preference to the merit of others, the other is the awkward struggling of nature over her own infirmities. The first gives an additional lustre to every good quality; while some people, from feeling the pain and inconveniency of the *mauvaise honte*, have rushed into the other extreme, and turned

impudent, as cowards sometimes grow desperate from excess of danger. The medium between these two extremes marks out the well-bred man; he feels himself firm and easy in all companies, is modest without being bashful, and steady without being impudent.

A man possessing the amiable virtues is still farther prepared to please, by having in his own mind a perpetual fund of satisfaction and entertainment. He is put to no trouble in concealing thoughts which it would be disgraceful to avow, and he is not anxious to display virtues which his daily conversation and his constant looks render visible.

The next ingredient in the art of pleasing, is to possess a correct and enlightened understanding, and a fund of rational knowledge. With virtue and modesty we must be able to entertain and instruct those with whom we associate.

The faculty of communicating ideas is peculiar to man, and the pleasure which he derives from the interchange alone is one of the most important of his blessings. Mankind are formed with numberless wants, and with a mutual power of assisting each other. It is a beautiful and happy part of the same perfect plan, that they are likewise formed to delight in each other's company, and in the mutual interchange of their thoughts. The different species of communication, in a highly polished age, are as numerous as the different ranks, employments, and occupations of men; and indeed the knowledge which men wish to communicate, takes its tinge from their peculiar profession or occupation.

Thus commercial men delight to talk of their trade, and of the nature of public business; men of pleasure, who wish merely to vary or quicken their amusements, are in conversation light, trifling, and insincere; and the literati delight to dwell on new books, learned men, and important discoveries in science or in arts. But as the different classes of men will frequently meet together, all parties must so contrive matters, as to combine the useful and agreeable together, so as to give the greatest delight at the time, and the greatest pleasure on reflection. An attention to these principles would make the man of pleasure and the man of learning meet together on equal terms, and derive mutual advantage from their different qualifications. With due attention to such ideas, we proceed to mention the kinds of knowledge which are most fitted for conversation. Those who wish to please should particularly endeavour to be informed in those points which most generally occur. An accurate or extensive knowledge on learned subjects is by no means sufficient: we must also have an accurate and extensive knowledge of the common occurrences of life.

It is the knowledge of mankind, of governments, of history, of public characters, and of the springs which put the great and the little actions of the world in motion, which give real pleasure and rational instruction. The knowledge which we communicate must in some shape be interesting to those to whom we communicate it; of that nature, that the desire of receiving it may overbalance every kind of disgust, excited too often on the score of envy and self-love, against those who happen to possess superior endowments, and at the same time of that importance, as to elevate the thoughts somewhat above the actions and the faults of the narrow circle formed in our own immediate neighbourhood.

Politeness.

Politeness bourhood. On this account it is recommended by an author who fully knew mankind, as a maxim of great importance in the art of pleasing, to be acquainted with the private character of those men who, from their station or their actions, are making a figure in the world. We naturally wish to see such men in their retired and undisguised moments; and he who can gratify us is highly acceptable. History of all kinds, fitly introduced, and occasionally embellished with pleasing anecdotes, is a chief part of our entertainment in the intercourse of life. This is receiving instruction, without exciting much envy; it depends on memory, and memory is one of those talents the possession of which we least grudge to our neighbour. Our knowledge of history, at the same time, must not appear in long and tedious details; but in apt and well-chosen allusions, calculated to illustrate the particular subject of conversation. But the knowledge most necessary is that of the human heart. This is acquired by constant observation on the manners and maxims of the world, connected with that which passes in our own minds. This leads us from the common details of conduct, from slander and defamation, to the sources and principles of action, and enables us to enter into what may be called the philosophy of conversation. We may see both the practicability of this kind of discourse, and the nature of it, in the following lines of Horace:

Sermo oritur, non de villis domibusve alienis;
Nec male necne Lepos saltet: sed quod magis ad nos
Pertinet, & nescire malum est, agitamus: utrumne
Divitiis homines, an sint virtute beati?
Quidve ad amicitias, usus rectumne, trahat nos?
Et quæ sit natura boni, summumque quid ejus? &c.

By this means constant materials are supplied for free, easy, and spirited communication. The restraints which are imposed on mankind, either from what their own character may suffer, or from the apprehension of giving offence to others, are entirely taken off, and they have a sufficient quantity of current coin for all the common purposes of life.

In addition to virtue and knowledge, which are the chief ingredients in the art of pleasing, we have to consider graceful and easy manners. Lord Chesterfield indeed considers these as the most essential and important part; as if the diamond received its whole value from the polish. But though he is unquestionably mistaken, there is yet a certain sweetness of manners which is particularly engaging in our commerce with the world. It is that which constitutes the character which the French, under the appellation of *Paimable*, so much talk of, and so justly value. This is not so easily described as felt. It is the compound result of different things; as complaisance, a flexibility, but not a servility of manners, an air of softness in the countenance, gesture, and expression, equally whether you concur or differ with the person you converse with. This is particularly to be studied when we are obliged to refuse a favour asked of us, or to say what in itself cannot be very agreeable to the person to whom we say it. It is then the necessary gilding of a disagreeable pill. But this, which may be called the *suaviter in modo*, would degenerate and sink into a mean and timid complaisance and passiveness, if not supported by firmness and dignity of character. Hence the Latin sentence, *suaviter in modo,*

fortiter in re, becomes a useful and important maxim in *Politeness*. life.

Genuine easy manners result from a constant attention to the relations of persons, things, time, and places. Were we to converse with one greatly our superior, we are to be as easy and unembarrassed as with our equals; but yet every look, word, and action, should imply, without any kind of servile flattery, the greatest respect. In mixed companies, with our equals, greater ease and liberty are allowed; but they too have their proper limits. There is a social respect necessary. Our words, gestures, and attitudes, have a greater degree of latitude, though not an unbounded one. That easiness of carriage and behaviour which is exceedingly engaging, widely differs from negligence and inattention, and by no means implies that one may do whatever he pleases; it only means, that one is not to be stiff, formal, and embarrassed, disconcerted and ashamed; but it requires great attention to, and a scrupulous observation of, what the French call *les bienséances*; a word which implies "decorum, good-breeding, and propriety." Whatever we ought to do, is to be done with ease and unconcern; whatever is improper, must not be done at all. In mixed companies, also, different ages and sexes are to be differently addressed. Although we are to be equally easy with all, old age particularly requires to be treated with a degree of deference and regard. It is a good general rule, to accustom ourselves to have a kind feeling to every thing connected with man; and when this is the case, we shall seldom err in the application. Another important point in the *bienséances* is, not to run our own present humour and disposition indiscriminately against every body, but to observe and adopt theirs. And if we cannot command one present humour and disposition, it is necessary to single out those to converse with who happen to be in the humour the nearest to our own. Peremptoriness and decision, especially in young people, is contrary to the *bienséances*: they should seldom seem to dissent, and always use some softening mitigating expression.

There is a *bienséance* also with regard to people of the lowest degree; a gentleman observes it with his footman, and even indeed with the beggar in the street. He considers them as objects of compassion, not of insult; he speaks to neither in a harsh tone, but corrects the one coolly, and refuses the other with humanity.

The following observations perhaps contain the sum of the art of pleasing:

1. A fixed and habitual resolution of endeavouring to please, is a circumstance which will seldom fail of effect, and its effect will every day become more visible as this habit increases in strength.
2. This resolution must be regulated by a very considerable degree of good sense.
3. It is a maxim of almost general application, that what pleases us in another will also please others in us.
4. A constant and habitual attention to the different dispositions of mankind, to their ruling passions, and to their peculiar or occasional humours, is absolutely necessary.
5. A man who would please, must possess a firm, equal, and steady temper. And,
6. An easy and graceful manner, as distant from bashfulness on the one hand as from impudence on the other.

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other. "He who thinks himself sure of pleasing (says Lord Chesterfield), and he who despairs of it, are equally sure to fail." And he is undoubtedly in the right. The one, by his assuming vanity, is inattentive to the means of pleasing; and the other, from fear, is rendered incapable of employing them.

A variety of excellent rules for acquiring politeness, with strictures on particular kinds of impoliteness, may be found in the *Spectator*, *Rambler*, *Idler*, *Lounger*, *Mirror*, and other periodical works of that kind; in *Knox's Essays*, and among *Swift's Works*; see *Good MANNERS*. *Chesterfield's Art of Pleasing*, and his *Letters*, are also worthy of perusal, provided the reader be on his guard against the insincerity and other vices which those books are calculated to infuse, and provided he always bears in mind what we have endeavoured to shew in this article, that true politeness does not consist in specious manners and a dissimulating address, but that it must always be founded on real worth and intrinsic virtue.

POLITIAN (Angelo), was born at Monte Pulciano in Tuscany in 1454. He learned the Greek tongue, of which he became a complete master, under Andronicus of Thessalonica. He is said to have written verses both in Greek and Latin when he was not more than 12 years of age. He studied also the Platonic philosophy under Marsilius Ficinus, and that of Aristotle under Argyropylus. He was one of the most learned and polite writers of his time. The first work which gained him a reputation was a poem on the tournament of Julian de Medicis. The account he wrote some time after of the conspiracy of the Pazzi's was very much esteemed. He wrote many other pieces which have merited approbation; and had he lived longer, he would have enriched the republic of letters with many excellent works; but he died at the age of 40 years. His morals answered the homeliness of his face rather than the beauty of his genius; for Paul Jovius informs us, that "he was a man of awkward and perverse manners, of a countenance by no means open and liberal, a nose remarkably large, and squinting eyes. He was crafty, satirical, and full of inward malice: for his constant way was, to sneer and ridicule the productions of other men, and never to allow any criticism, however just, upon his own."

He was, nevertheless, as all acknowledge, a man of most consummate erudition; and not only so, but a very polite and elegant writer. Erasmus, in his *Ciceronianus*, calls him a rare miracle of nature, on account of his excelling in every kind of writing: his words are remarkable: "*Fateor Angelum prorsus angelica fuisse mente, rarum naturæ miraculum, ad quodcunque scripti genus applicaret animum.*" Some of his poems were so much admired, that several learned men have made it their business to comment on them. It has been often reported that he spoke of the Bible with great contempt; and that, having read it but once, he complained he had never spent his time so ill. But this is not probable, for it must be remembered that he was a priest and canon of Florence; and we learn from one of his Epistles that he preached a whole Lent. It does not indeed follow hence, that he did not think contemptuously of the Bible, because many of his church, especially among the better sort, have not been very good believers, and he might be one of them: but it is not likely he would speak out so freely. "I could

(as Bayle says) much more easily believe the judgment he is said to have made on the Psalms of David and the Odes of Pindar: he did not deny that there are many good and fine things in the Psalms; but he pretended that the same things appear in Pindar with more brightness and sweetness." The two Scaligers have spoken highly of Politian: the elder has preferred a consolatory elegy of his to that which Ovid sent to Livy upon the death of Drusus, and says, he had rather have been the author of it: the younger calls him an excellent poet, but thinks the style of his epistles too elated and declamatory.

His works have been printed at various times, and in various places: his epistles have probably been most read, because these are things which the generality of people are best pleased with.

POLITICAL, from πολις "a city," signifies any thing that relates to policy or civil government.

POLITICAL Arithmetic, is the art of reasoning by figures upon matters relating to government, such as the revenues, number of people, extent and value of land, taxes, trade, &c. in any nation.

These calculations are generally made with a view to ascertain the comparative strength, prosperity, &c. of any two or more nations. With this view, Sir William Petty, in his *Political Arithmetic*, p. 74, &c. computes the land of Holland and Zealand to be about 1,000,000 acres, and that of France to be 8,000,000; and yet the former is one-third part as rich and strong as the latter. The shipping of Europe he computes to be about 2,000,000, of which Britain has 500,000; Holland 900,000; France 100,000; Hamburg, Denmark, Sweden, and Dantzic 250,000; and Spain, Portugal, Italy, &c. the rest. The exports of France he computes at L. 5,000,000, of which one-fourth came to Britain; of Holland L. 18,000,000, of which L. 300,000 came to Britain. The money raised yearly by the king of France was about L. 6,500,000 Sterling; that of all the Dutch provinces L. 3,000,000, of which 2,100,000 was raised in Holland and Zealand. The number of people in England he computed to be six millions, and their expences, at L. 7 per annum a head, L. 42,000,000; the rent of land L. 8,000,000; and the interests, &c. of personal estates as much, the rents of houses L. 4,000,000, and the profits of labour L. 26,000,000. The people of Ireland he reckoned 1,200,000. The corn spent in England, at 5s. a bushel for wheat, and 2s. 6d. for barley, amounts to L. 10,000,000 a-year. The navy of England then required 36,000 men to man it, and other trade and shipping 48,000. In France, to manage the whole shipping trade, there were then required only 1500 men. The whole people of France were 13,500,000; and those of England, Scotland, and Ireland, about 9,500,000. In the three kingdoms are about 20,000 churchmen, and in France more than 270,000. In the dominions of England were above 40,000 seamen, and in France not more than 10,000. In England, Scotland, and Ireland, and all their dependencies, there was then about 60,000 ton of shipping, worth about 4,500,000 in money. The sea-line round England, Scotland, and Ireland, and the adjacent isles, is about 3800 miles. In the whole world he reckoned about 350,000,000 of people; and those with whom the English and Dutch have any commerce, not more than eighty millions; and the value of commodities

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commodities annually traded for in the whole not above L. 45,000,000. That the manufactures exported from England amounted to about L. 5,000,000 *per annum*; lead, tin, and coals, to L. 500,000 *per annum*. The value of the French commodities then brought into England did not exceed L. 1,200,000 *per annum*; and the whole cash of England in current money was then about L. 6,000,000 Sterling.

With these calculations Dr Davenant was dissatisfied; and therefore, from the observations of Mr Greg. King, he advanced others of his own. He reckons the land of England 39 millions of acres; the number of people 5 millions and a half, increasing 9000 a year, making allowance for wars, plagues, and other accidents. He reckons the inhabitants of London 530,000; of other cities and market-towns in England 870,000; and those of villages, &c. 4,100,000. The yearly rent of land he reckons L. 10,000,000; of houses, &c. 2,000,000; the produce of all kinds of grain in a tolerable year L. 9,075,000; the annual rent of corn lands L. 2,200,000, and their net produce L. 9,000,000; the rent of pasture, meadows, woods, forests, commons, heaths, &c. L. 7,000,000; the annual produce by cattle in butter, cheese, and milk, about L. 2,500,000; the value of the wool yearly shorn about L. 2,000,000; of horses yearly bred about L. 250,000; of the flesh yearly spent as food about L. 3,350,000; of the tallow and hides about L. 600,000; of the hay yearly consumed by horses about L. 1,300,000; of the hay consumed by other cattle L. 1,000,000; of the timber yearly felled for building L. 500,000; and of the wood yearly spent in firing, &c. about L. 500,000. The proportion of the land of England to its inhabitants is now about 7½ acres per head; the value of the wheat, rye, and barley, necessary for the sustenance of England, amounts to at least L. 6,000,000 Sterling *per annum*; of the woollen manufacture about L. 8,000,000 *per annum*, and exports of all kinds of the woollen manufacture amount to above L. 2,000,000 *per annum*; the annual income of England, on which the whole people subsist, and out of which all taxes are paid, is reckoned to be about L. 43,000,000, that of France L. 81,000,000, and of Holland L. 18,250,000. See Davenant's *Essay on Trade*, in vol. vi. of his works. For calculations respecting mortality, see Major Grant's *Observations on the Bills of Mortality*, and our article *Bills of Mortality*.

In Vol. XLIX. of the Philosophical Transactions we have an estimate of the number of people in England by Dr Brakenridge, from considering the number of houses and quantity of bread consumed. On the former principle he computes the number of people to be 6,257,418 of all ages, counting in England and Wales 911,310 houses, and allowing six persons to a house. From a survey of the window-lights after the year 1750, the number of houses charged in England and Wales were 690,000, besides 200,000 cottages that pay nothing; the whole number therefore was 890,000, and the number of people, allowing six to a house, 5,340,000. On the latter principle, he estimates the number of quarters of wheat consumed at home to be 2,026,100; and allowing a quarter for three persons in a year, or seven ounces a day for each person, he concludes the number of people to be 6,078,300. Of this number, according to Dr Halley's rule, he suppo-

ses about 1,500,000 men able to carry arms. The country he supposes capable of supporting one-half more inhabitants, or 9,000,000; for, according to Mr Templeman's survey, England contains 49,450 square miles, that is, 31,648,000 acres, of which 25,300,000 acres are proper to be cultivated; and allowing three acres, well manured, for the maintenance of one person, there will be maintenance in England for 8,430,000 people; to which add the produce of fishing, and it will enable the country to support 9,000,000. In Ireland, Mr Templeman reckons 17,536,000 acres, of which Dr Brakenridge thinks 12,000,000 are capable of cultivation; and allowing four acres to each person, and the number of inhabitants to be only 1,000,000, Ireland could maintain 2,000,000 more people than it has now. In Scotland, containing 1,500,000 people, and 17,728,000 acres of land, of which there are 11,000,000 good acres, allowing five for each person, he supposes there may be provision for 2,200,000 people, or for 700,000 more than there are at present. Hence he infers, that were both the British isles properly cultivated, there is a provision for 6,000,000 inhabitants beyond the present number. Extending his survey to the whole globe, he supposes the whole surface to be to the quantity of land as 8 to 3, *i. e.* as 197,819,550 to 74,182,331 square miles; out of which, deducting one-third for waste-ground, there will be 49,454,887 square miles, or 31,651,127,680 good acres. And stating the whole number of inhabitants on the globe to be 400,000,000, there will be 79 good acres to each person. See Dr Halley's *Calculations* on the same subject, and Dr Price's (for a list of whose works see his life at the word PRICE), and King on the *National Debt*.

POLITICS, the first part of economy or ethics, consisting in the well governing and regulating the affairs of a state for the maintenance of the public safety, order, tranquillity, and morals.

Lord Bacon divides politics into three parts, viz. the preservation of the state, its happiness and flourishing, and its enlargement. Of the first two, he informs us, various authors have treated, but the last has never been handled; and he has given a specimen of an essay to supply the want.

POLITY, or POLICY, denotes the peculiar form and constitution of the government of any state or nation; or the laws, orders, and regulations, relating thereto*. — Polity differs only from politics, as the theory from the practice of any art.

* See Government.

Of the nature of our social duties, both private and political, we have already spoken at some length (see *Moral Philosophy*, Part II. chap. iii. and particularly sect. vii.); and we shall have occasion to take a view of the origin and nature of the several political establishments of Europe, &c. hereafter. (See *Civil Society*.) We shall only further remark in this place upon the necessity of always joining politics and morality together. This view of the subject is indeed antiquated and neglected; but the connection has always been externally respected even by those who have separated them the most widely. Politics and morality, far from standing in opposition to each other, have the most intimate connection, and exhibit the relation which the *part* bears to the *whole*; that is to say, that politics are only a part or a branch of morality. No truth can be more evident than this; for

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for as morality is the guide of human life, the principle of order, and the universal source of real improvement and genuine happiness to all mankind, every thing relative to the direction of individuals, or the government of nations, must be comprehended within its sphere, and be subservient to its laws. All the schemes and projects of pretended political wisdom, that deviate from or violate the rules of this master-science, turn out in the issue often to the detriment of their contrivers, always to that of the nation; and it is a palpable and absurd error to think of advancing the happiness of one country at the expence of the general good of mankind. The experience of ages, and the history of the world, confirm these assertions; from which, and from daily observation, we obtain a convincing proof of the wisdom of the good old maxim, both in its application to individuals and to nations, that "honesty is the best policy." See Baron Dahlberg's *Considerations on the Connection between Morality and Politics*, read by himself to the Academy of Sciences at Erfurt.

POLL, a word used in ancient writings for the head: hence to poll, is either to vote, or to enter down the names of those persons who give their votes at an election.

Poll-Evil. See FARRIERY, § xxxii.

Poll-Money, or *Capitation*, a tax imposed by authority of parliament, on the person or head; either on all indifferently, or according to some known mark or distinction, as quality, calling, &c.

Thus, by the statute 18 Car. II. every subject in the kingdom was assessed by the head, or poll, according to his degree; every duke L. 100, marquis L. 80, baronet L. 30, knight L. 20, esquire L. 10, &c. and every single private person 12d.

This was no new tax, as appears by former acts of parliament.

POLLACHIUS, or POLLACK. See GADUS.

POLLARD, or CROCARD, the name of a sort of base money current in Ireland in the time of Edward I. See *Simon's History of Irish Coins*, p. 15.

POLLEN, the fecundating or fertilizing dust contained within the antheræ or tops of the stamina, and dispersed upon the female organ when ripe for the purposes of impregnation. See BOTANY.

This dust, corresponding to the seminal fluid in animals, is commonly of a yellow colour; and is very conspicuous in the summits of some flowers, as the tulip and lily. Its particles are very minute, and of extreme hardness. Examined by the microscope, they are generally found to assume some determinate form, which often predominates, not only through all the species of a particular genus, but also through the genera of a natural family or order. The powder in question being triturated, and otherwise prepared in the stomach of bees, by whom great quantities are collected in the hairy brushes with which their legs are covered, is supposed by some authors to produce the substance known by the name of *wax*; a species of vegetable oil, rendered concrete by the presence of an acid, which must be removed before the substance can be rendered fluid.

POLLENTIA, a town or colony of Roman citizens in the Balearis Major. It is now said to be Alcudia, situated on the north-east side of the island Majorca. There was another *Pollentia* of the Picenum, likewise a colony. It is thought to be either the same

with or near to the Urbs Salvia, but is now extinct. There was a third of Liguria, situated at the confluence of the Stura and Tanarus. Suetonius calls it a municipium, and the people *Pollentina Plebs*. It was famous for its abundance of black fleeces; but was afterwards, under Arcadius and Honorius, stained with a defeat rather of the Romans under Stilico than of the Goths under Alaricus, though palliated by Claudian the poet; after which Rome was taken and set on fire. It is now called *Solenza*, a small town of Piedmont, not far from Asti.

POLLEX, in anatomy, denotes either the thumb or great toe, according as *manus* or *pedis* is added to it.

POLLICHIA, in botany: A genus of the monogynia order, belonging to the monandria class of plants; and in the natural method ranking with those that are doubtful. Of this there is only one species, *viz.* the *campestris*, or whorl-leaved pollichia, a native of the Cape of Good Hope, and flowers in September.

POLLICIPES, the TOE-SHELL, in natural history, is the name of a genus of shells, the characters of which are these: they are multivalve flat shells, of a triangular figure, each being composed of several laminae, which end in a sharp point. They stand upon pedicles, and are furnished with a great number of hairs. We have only one known species of this genus, which is always found in large clusters.

POLLICIS PRESSIO, and POLLICIS VERSIO, were used at the combats of gladiators as signals of life or death to the vanquished combatant; or to the victor to spare or take the life of his antagonist. The *pollicis pressio*, by which the people granted life to the prostrate gladiator, was no more than a clenching of the fingers of both hands together, and so holding the two thumbs upright close together. The *pollicis versio*, which authorised the victor to kill the other as a coward, was the bending back of the thumbs. Such is Dacier's opinion; but others say the *pollicis pressio* was when the people held up one hand with the thumb bent, and the *pollicis versio* when they showed the hand with the thumb raised. Authors, however, are not perfectly agreed, though the phrases *pollicem premere*, and *pollicemvertere*, frequently occur in the Latin classics as indications of the people's will that a gladiator should live or die.

POLLIO (Caius Asinius), a celebrated Latin poet and orator, was of consular dignity, and composed some tragedies which were esteemed, but are now lost. He was the first who opened at Rome a library for the use of the public. He was the friend of Mark Antony; which prevented his complying with the solicitations of Augustus, who pressed him to embrace his party. At length Augustus having wrote some verses against Pollio, he was urged to answer them: on which he said, "I shall take care of writing against a man who has the power of proscribing us." He is praised by Virgil and Horace, whose patron he was.

There was another *Pollio*, a friend of Augustus, who used to feed his fishes with human flesh. This cruelty was discovered when one of his servants broke a glass in the presence of Augustus, who had been invited to a feast. The master ordered the servant to be seized, but he threw himself at the feet of the emperor, and begged him to interfere, and not to suffer him to be devoured by fishes. Upon this the causes of his apprehension were

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Pollution, were examined; and Augustus, astonished at the barbarity of his favourite, caused the servant to be dismissed, all the fish ponds to be filled up, and the crystal glasses of Pollio to be broken to pieces.

POLLUTION, in general, signifies defilement, or the rendering a person or place unclean or unholy. For the Jewish pollutions, see the article **IMPURITY**.

The Romanists hold a church to be polluted by the effusion of blood or of seed therein; and that it must be consecrated anew. And the Indians are so superstitious on this head, that they break all the vessels which those of another religion have drank out of, or even only touched; and drain all the water out of a pond in which a stranger has bathed.

POLLUTION, in medicine, a disease which consists in an involuntary emission of the seed in time of sleep. This, in different persons, is very different in degree; some being affected with it only once in a week, a fortnight, three weeks, or a month, and others being subject to it almost every night. The persons most subject to it, are young men of a sanguineous temperament, who feed high and lead a sedentary life. When this happens to a person but once in a fortnight or a month, it is of no great consequence; but when it happens almost every night, it greatly injures the health; the patient looks pale and sickly; in some the eyes become weak and inflamed, are sometimes affected with violent discharges, and are usually at last encircled with a livid appearance of the skin. This distemper is to be cured rather by a change of life than by medicines. When it has taken its rise from a high diet and a sedentary life, a coarser food and the use of exercise will generally cure it. Persons subject to this disease should never take any stimulating purges, and must avoid as much as possible all violent passions of the mind: and though exercise is recommended in moderation, yet if this be too violent, it will rather increase the disorder than contribute to its cure.

Self-POLLUTION. See **ONANISM**.

POLLUX (Julius), a Greek writer of antiquity, flourished in the reign of the emperor Commodus, and was born at Naucrates, a town in Egypt. He was educated under the sophists, and made great progress in grammatical and critical learning. He taught rhetoric at Athens, and became so famous that he was made preceptor of the emperor Commodus. He drew up for his use, and inscribed to him, while his father Marcus Antoninus was living, an *Onomasticon* or Greek Vocabulary, divided into ten books. It is extant, and contains a vast variety of synonymous words and phrases, agreeably to the copiousness of the Greek tongue, ranged under the general classes of things. It was intended to facilitate the knowledge of the Greek language to the young prince; and it is still very useful to all who have a mind to be perfect in it. The first edition of it was printed at Venice by Aldus in 1502, and a Latin version was afterwards made and published with it: but there was no correct and handsome edition of it till that of Amsterdam, 1706, in folio, by Lederlinus and Hemsterhusius. Lederlinus went through the first seven books, correcting the text and version, and subjoining his own, with the notes of Salmasius, If. Vossius, Valesius, and of Kuhnus, whose scholar he had been, and whom he succeeded in the professorship of the oriental languages in the university of Strasburg.

VOL. XV. Part I.

Hemsterhusius continued the same method through the three last books: this learned man has since distinguished himself by an excellent edition of Lucian, and other monuments of solid and profound literature.

Pollux wrote many other things, none of which remain. He lived to the age of 58. Philostratus and Lucian have treated him with much contempt and ridicule. *Philostat. de vit. Sophist.* lib. ii. and *Lucian in Rhetorum præceptore*.

POLLUX. See **CASTOR** and **POLLUX**.

POLLUX, in astronomy, a fixed star of the second magnitude in the constellation Gemini, or the Twins. See **CASTOR**.

POLLUX and Castor, a fiery meteor. See **CASTOR** and *Pollux*.

POLOCSKI, a palatinate in the duchy of Lithuania, bounded on the north by the palatinate of Weytepski, on the south by the Dwina, on the north by Muscovy, and on the west by Livonia. It is a desert country full of wood, and had formerly its own dukes.

POLOCSKI, a town of Lithuania, and capital of a palatinate of the same name, with two castles to defend it. It was taken by the Muscovites in 1563, and retaken the same year. It is seated on the river Dwina, 50 miles south-west of Weytepski, and 80 east of Brallaw. E. Long. 29. O. N. Lat. 56. 4.

POLTROON, or **POLTRON**, a coward or dastard, wanting courage to perform any thing great or noble. The word is borrowed from the French, who according to Salmasius, derive it a *pollice truncato*; because anciently those who would avoid going to the wars cut off their thumb. But Menage, with more probability, derives it from the Italian *poltrone*, and that from *poltro* a "bed;" because timorous, pusillanimous people take pleasure in lying a-bed. Others choose to derive the word from the Italian *poltro* a "colt;" because of that creature's readiness to run away.

POLVERINE, the calcined ashes of a plant; of a similar nature with our pot-ashes or pearl-ashes. It is brought from the Levant and Syria; and in the glass-trade it is always to be preferred to any other ashes. The barilla, or pot-ashes of Spain, yield more pure salt than the pulverine of the Levant, but the glass made with it has always some blue tinge: that made with the pulverine is perfectly white, which ought always to be used for the finest crystal.

POLYADELPHIA (from *πολυς* many, and *ἀδελφία* brotherhood), many brotherhoods. The name of the 18th class of Linnæus's sexual system, consisting of plants with hermaphrodite flowers, in which several stamina or male organs are united by their filaments into three or more distinct bundles.

POLYÆNUS, the name of many famous men recorded in ancient writers. Among them was Julius Polyænus, of whom we have some Greek epigrams extant in the first book of the *Anthologia*. The Polyænus whom it most concerns us to know about, is the author of the eight books of the *Stratagems of illustrious Commanders in War*. He was probably a Macedonian, and perhaps a soldier in the early part of his life; but of this there is no certainty. He was undoubtedly a rhetorician and a pleader of causes; and appears, from the dedication of his work to the emperors Antoninus and Verus, to have lived towards the latter part of the second century. The *Stratagemata* were published

Polyandria in Greek by Isaac Casaubon, with notes, in 1589, 12mo; but no good edition of them appeared till that of Leyden, 1690, in 8vo. The title-page runs thus: *Polyeni Stratagematum libri octo, Justo Vulteio interprete, Pancratius Maasvicius recensuit, Isaaci Casauboni nec non suas notas adjecit.*

||
Polybius.

We have in this work the various stratagems of above 300 captains and generals of armies, chiefly Greeks and barbarians: for the Romans seldom used such finesses; and Polyænus has shown further, that he was not well versed in Roman affairs. A great number of these stratagems appear to us to be ridiculous or impracticable; and neither the generals, nor even common soldiers of our days, would be found simple enough to be caught by them. Few of this order are capable of reading *Polyænus's Stratagems*; and if they were, they would reap little benefit from it. The book is useful to such as study the Greek language and antiquity; for many things will be found in it, illustrating the customs and opinions of ancient times. The sixth and seventh books are imperfect.

Polyænus composed other works besides the *Stratagemata*. Stobæus has produced some passages out of a book *De Republica Macedonum*; and Suidas mentions a piece concerning the Thebans and three books of Tacitus. If death had not prevented, he would have written *Memorabilia of the Emperors Antoninus and Verus*: for he makes a promise of this in the preface to his sixth book of *Stratagems*. Casaubon, in the dedication of Polyænus to Mornæus, calls him *an elegant, acute, and learned writer*.

POLYANDRIA (from *πολυς* many, and *ανη* a man or husband), many husbands. The name of the 13th class in Linnæus's sexual method, consisting of plants with hermaphrodite flowers, which are furnished with several stamina, that are inserted into the common receptacle of the flower.

POLYANTHEA, a collection of common-places in alphabetical order, for the use of orators, preachers, &c. The word is formed from the Greek *πολυς* much, and *ανθος* flower; and has much the same meaning with *anthology* or *florilege*. The first author of the *polyanthea* was Dominic Nanni de Mirabellio, whose labour has been improved on by Barth. Amantius, and Franc. Torfius; and since these, by Jos. Langius, under the title of *Polyanthea nova*, 1613.

POLYANTHUS, in botany. See **PRIMULA**.

POLYBIUS, a famous Greek historian, was born at Megalopolis, a city of Arcadia, 205 years before Christ; and was the son of Lycortas, chief of the republic of the Achæans. He was trained to arms under the celebrated Philopœmen, and is described by Plutarch carrying the urn of that great but unfortunate general in his funeral procession. He arose to considerable honours in his own country, but was compelled to visit Rome with other principal Achæans, who were detained there as pledges for the submission of their state. From hence he became intimate with the second Scipio Africanus, and was present with him at the demolition of Carthage. He saw Corinth also plundered by Mummius, and thence passing through the cities of Achaia, reconciled them to Rome. He extended his travels into Egypt, France, and Spain, that he might avoid such geographical errors as he has censured in others.

It was in Rome that he composed his excellent his-

tory, for the sake of which his travels were undertaken. **Polycarp.** This history was divided into 40 books; but there only remains the five first, with extracts of some parts of the others. It has had several editions in Greek and Latin; and there is an English translation by Mr Hampton. He died at the age of 82.

POLYCARP, one of the most ancient fathers of the Christian church, was born towards the end of the reign of Nero, probably at Smyrna; where he was educated at the expence of Calista, a noble matron distinguished by her piety and charity. He was unquestionably a disciple of St John the Evangelist, and conversed familiarly with other of the apostles. When of a proper age, Bucolus ordained him a deacon and catechist of his church; and upon his death he succeeded him in the bishopric, to which he is said to have been consecrated by St John, who also directed his *Apocalypse*, among others, to him, under the title of *the angel of the church of Smyrna*. At length the controversy about the observation of Easter beginning to grow high between the eastern and western churches, he went to Rome to discourse with those who were of the opposite party. The see was then possessed by Anicetus, with whom he had many conferences, that were carried on in the most peaceable and amicable manner; and though neither of them could bring the other to embrace his opinion, they both retained their own sentiments without violating that charity which is the great law of their religion.

Whilst at Rome he particularly opposed the heresies of Marcian and Valentinus. His conduct on this occasion is related by Irenæus; who informs us, that when Polycarp passed Marcian in the street without speaking, Marcian said, "Polycarp, own us!" To which he replied with indignation, "I own thee to be the first-born of Satan." Irenæus adds, that when any heretical doctrines were spoken in his presence, he would stop his ears and say, "Good God! to what times hast thou reserved me, that I should hear such things!" and immediately left the place. He was wont to tell, that St John, going into a bath at Ephesus, and finding Cerinthus the heretic in it, immediately started back without bathing, crying out, "Let us run away, lest the bath should fall upon us while Cerinthus the enemy of truth is in it." Polycarp governed the church of Smyrna with apostolic purity, till he suffered martyrdom in the 7th year of Marcus Aurelius; the manner of which is thus related.

The persecution waxing hot at Smyrna, and many having sealed their faith with their blood, the general cry was, "Away with the impious; let Polycarp be sought for." Upon which he privately withdrew into a neighbouring village, where he continued for some time praying night and day for the peace of the church. He was thus employed, when one night he fell into a trance, and dreamed that his pillow took fire, and was burnt to ashes; which, when he awoke, he told his friends was a preface that he should be burnt alive for the cause of Christ. Three days afterwards, in order to escape the incessant search for him, he retired into another village: his enemies, however, were at hand, who seized upon two youths (one of whom they forced by stripes to a confession), by whom they were conducted to his lodging. He might have saved himself by getting into another house; but he submitted, saying, "The will of the Lord be done." He therefore came down

Polycarp. down from his bed-chamber, and saluting his persecutors with a serene and cheerful countenance, he ordered a table to be set with provisions, invited them to partake of them, and only requested for himself one hour for prayer; after which he was set upon an ass, and conducted towards Smyrna. On the road he met Herod an irenarch or justice of the province, and his father, who were the principal instigators of the persecution. Herod took him up into his chariot, and strenuously endeavoured to undermine his constancy; but having failed in the attempt, he thrust him out of the chariot with so much violence and indignation, that he bruised his thigh with the fall. When at the place of execution, there came, as is said, a voice from heaven, saying, "Polycarp, be strong, and quit thyself like a man." Before the tribunal he was urged to swear by the genius of Cæsar. "Repent (says the proconsul), and say with us, take away the impious." Whereupon the martyr looking round at the crowd with a severe and angry countenance, beckoned with his hand, and looking up to heaven, said with a sigh, in a very different tone from what they meant, "Take away the impious." At last, confessing himself to be a Christian, the crier thrice proclaimed his confession, and the people shouted, "This is the great doctor of Asia, and the father of the Christians; this is the destroyer of our gods, that teaches men not to do sacrifice, or worship the deities." When the fire was prepared, Polycarp requested not to be nailed, as usual, but only tied to the stake; and after a short prayer, which he pronounced with a clear and audible voice, the executioner blew up the fire, which increasing to a mighty flame, "Behold a wonder seen (says my author) by us who were purposely reserved, that we might declare it to others; the flames disposing themselves into the resemblance of an arch, like the sails of a ship swelled with the wind, gently encircled the body of the martyr, who stood all the while in the midst, not like roasted flesh, but like the gold or silver purified in the furnace, his body sending forth a delightful fragrantcy, which, like frankincense or some other costly spices, presented itself to our senses. The infidels, exasperated by the miracle, commanded a spearman to run him through with a sword: which he had no sooner done, but such a vast quantity of blood flowed from the wound as extinguished the fire; when a dove was seen to fly from the wound, which some suppose to have been his soul, clothed in a visible shape at the time of its departure (A)." The Christians endeavoured to carry off his body entire, but were not allowed by the irenarch, who commanded it to be burnt to ashes. The bones, however, were gathered up, and decently interred by the Christians.

Thus died St Polycarp, the 7th of the kalends of May, A. C. 167. The amphitheatre on which he suffered was mostly remaining not many years ago; and his tomb, which is in a little chapel in the side of a

mountain, on the south-east of the city, was solemnly visited by the Greeks on his festival day; and for the maintenance and repairing of it, travellers were wont to throw a few aspers into an earthen pot that stands there for the purpose. He wrote some homilies and epistles, which are now lost, except that to the Philippians, which is a truly pious and Christian piece, containing short and useful precepts and rules of life, which St Jerome informs us was even in his time read in the public assemblies of the Asiatic churches. It is singularly useful in proving the authenticity of the books of the New Testament; for he has several passages and expressions from Matthew, Luke, the Acts, St Paul's Epistles to the Philippians, Ephesians, Galatians, Corinthians, Romans, Thessalonians, Colossians, 1st Timothy, 1st Epistle of St John, and 1st of Peter; and makes particular mention of St Paul's Epistle to the Ephesians. Indeed his whole Epistle consists of phrases and sentiments taken from the New Testament (B).

POLYCARPON, in botany: A genus of the triandria order, belonging to the triandria class of plants; and in the natural method ranking under the 22d order, *Caryophyllei*. The calyx is pentaphyllous; there are five very small ovate petals; the capsule is unilocular and trivalved.

POLYCHREST, in pharmacy, signifies a medicine that serves for many uses, or that cures many diseases.

Sul **POLYCHREST**, a compound salt made of equal parts of saltpetre and sulphur, deflagrated in a red-hot crucible.

POLYCNUM, in botany: A genus of the monogynia order, belonging to the triandria class of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. The calyx is triphyllous; and there are five caliciform petals, with one seed almost naked.

POLYCRATES, was a tyrant of Samos, famous for the good fortune which always attended him. He became very powerful; and got possession not only of the neighbouring islands, but also of some cities on the coast of Asia. He had a fleet of 100 ships of war, and was so universally esteemed, that Amasis the king of Egypt made a treaty of alliance with him. The Egyptian king was, however, afraid of his continued prosperity, and advised him to chequer his enjoyments, by relinquishing some of his most favourite objects. Polycrates, in compliance, threw into the sea a beautiful seal, the most valuable of his jewels. The loss of so precious a seal afflicted him for some time; but soon after he received as a present a large fish, in whose belly it was found. Amasis no sooner heard this, than he gave up all alliance with the tyrant of Samos, and observed, that sooner or later his good fortune would vanish. Some time after Polycrates visited Magnesia on the Mæander, where he had been invited by Orontes the governor. Here he was shamefully put to death, merely because the governor wished to terminate his prosperity. The

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(A) The miraculous part of this account is ridiculed by Dr Middleton in his Free Enquiry and Defence of it; but something is offered in its favour by Mr Jortin, who observes, "the circumstances are sufficient only to create a pause and a doubt." *Remarks on Eccl. Hist.* vol. i.

(B) Jortin, vol. i. p. 68. who to the particulars made out by Cotelierius, has added one from Galat. iv. 26. and another from Hebr. iv. 12, 13.

Polycrota daughter of Polycrates had dissuaded her father from going to the house of Orontes, on account of the bad dreams which she had, but in vain.

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Polygala.

POLYCROTA, in the naval architecture of the ancients, is a word used to express such of their galleys as had three, four, five, or more tiers of rowers, seated at different heights; they were distinguished by this term from the *monocrota*, or those which had only single rows of oars. The number of rows of rowers in the polycrota galleys has given occasion to some to suppose those vessels of such a height from the water as is scarce credible. Commentators are not at all agreed upon the construction of these vessels.

POLYDAMAS, was a famous athlete, who imitated Hercules in whatever he did. He killed a lion with his fist, and it is reported he could stop a chariot with his hand in its most rapid course. He was one day with some of his friends in a cave, when on a sudden a large piece of rock came tumbling down, and while all fled away he attempted to receive the falling fragment in his arms. His prodigious strength, however, was insufficient, and he was instantly crushed to pieces under the rock.

POLYDECTES, a son of Magnes, was king of the island of Seriphos. He received with great kindness Danae and her son Perseus, who had been exposed on the sea by Acrisius. He took great care of the education of Perseus; but becoming enamoured of Danae, he removed her from his kingdom, apprehensive of his resentment. He afterwards paid his addresses to Danae; and being rejected, he prepared to offer her violence. Danae fled to the altar of Minerva for protection; and Dictys, the brother of Polydectes, who had himself saved her from the sea-waters, opposed her ravisher, and armed himself in her defence. At this critical moment Perseus arrived; and with Medusa's head he turned into stones Polydectes, with the associates of his guilt. The crown of Seriphos was given to Dictys, who had shown himself so active in the cause of innocence.

POLYDORE VIRGIL. See VIRGIL.

POLYDORUS, a son of Priam by Hecuba, or, according to others, by Laothoe, the daughter of Altes, king of Pedasus. Being young and inexperienced when Troy was besieged by the Greeks, his father removed him to the court of Polymnestor, king of Thrace, to whose care he entrusted the greatest part of his treasures, till his country should be freed from foreign invasion. On the death of Priam, Polymnestor made himself master of the riches which were in his possession; and to ensure them the better, he murdered the young prince, and threw his body into the sea, where it was found by Hecuba. According to Virgil, his body was buried near the shore by his assassin; and there grew on his grave a myrtle, whose boughs dropped blood, when Æneas going to Italy, attempted to tear them from the tree.

POLYGALA, MILKWORT: A genus of the octandria order, belonging to the diadelphia class of plants; and in the natural method ranking under the 33d order, *Lomentaceæ*. The calyx is pentaphyllous, with two of its leaflets wing-shaped and coloured; the legumen is obcordate and bilocular. There are 24 species; of which the most remarkable are,

1. The vulgaris, or common milkwort, is a native of

the British heaths and dry pastures. The stalks are about five or six inches long, several arising from the same root: the leaves are firm, smooth, entire, and grow alternate upon the stalks, which are terminated with spikes of flowers, most commonly blue, but often red or white: the calyx consists of five leaves, three of which are small and green, two below, and one above the corolla; the other two intermediate ones are large, oval, flat-coloured, veined, and resemble petals, which at length turn greenish, and remain a defence to the seed-vessel; the corolla consists of three petals folded together, and forming a tube: the carina is terminated by a kind of heart-shaped, concave appendage, fringed at the extremity. The root of this plant has a bitter taste, and has been found to possess the virtues of the American rattlesnake-root. It purges without danger, and is also emetic and diuretic; sometimes operating all the three ways at once. A spoonful of the decoction made by boiling an ounce of the herb in a pint of water till one half has exhaled, has been found serviceable in pleurisies and fevers, by promoting a diaphoresis and expectoration; and three spoonfuls of the same, taken once an hour, has proved beneficial in the dropy and anasarca. It has also been found serviceable in consumptive complaints.

2. The senega, or seneka, rattlesnake-wort, grows naturally in most parts of North America. This hath a perennial root composed of several fleshy fibres, from which arise three or four branching stalks which grow erect, garnished with spear-shaped leaves placed alternately. The flowers are produced in loose spikes at the end of the branches: they are small, white, and shaped like those of the common fort. It flowers here in July, but the plants do not produce seeds. The root of this species operates more powerfully than the last; but besides the virtues of a purgative, emetic, and diuretic, it has been recommended as an antidote against the poison of a rattlesnake; but this opinion is now exploded. It still, however, maintains its character in several disorders. Its efficacy, particularly in pleurisies, is most fully established in Virginia: formerly near 50 out of 100 died of that distemper, but by the happy use of this root hardly three out of the same number have been lost.

As the seeds of the rattlesnake-wort seldom succeed even in the countries where the plant is a native, the best method of propagating it is to procure the roots from America, and plant them in a bed of light earth in a sheltered situation, where they will thrive without any other culture than keeping them free from weeds. But though the plant will stand out ordinary winters, it will be proper to cover it during that season with old tanner's bark, or other mulch, to keep out the frost.

POLYGAMIA (*πολυς many*, and *γαμος marriage*). This term, expressing an intercommunication of sexes, is applied, by Linnæus, both to plants and flowers. A polygamous plant is that which bears both hermaphrodite flowers and male or female, or both.

POLYGAMY, a plurality of wives or husbands, in the possession of one man or woman at the same time.

Polygamy is so universally esteemed unlawful, and even unnatural, through Europe, and in all Christian countries, that we have generally reasoned upon this conviction. Both religion and reason appear at first sight at least to condemn it; and with this view of the subject

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Polygala
||
Polygamy.

Polygamy Subject mankind in general rest satisfied: but some bolder geniuses have taken the opposite side of the question; have cast off the prejudices of education, and attempted to show that polygamy is not unlawful, but that it is just and necessary, and would be a public benefit. Such writers, to use the words of an intelligent critic*, "recur to the common subterfuge, of which every setter up of strange gods, and every CONSCIENTIOUS troubler of the public peace, have artfully availed themselves to silence the clamour of expostulation. 'TRUTH! TRUTH!' is their general cry: and with this hopeful pretence, prudence and humility, and every amiable and useful virtue, are left behind; while CONSCIENCE (conscience!) blindly rushes forward to oppose order, insult authority, and overturn the customs of ages."

Monthly
review,
vol. 63.
274.

But notwithstanding these fair pretences, it will, we doubt not, be easy to show that truth is not upon their side; prudence and delicacy are certainly at open war with them: for Dr Percival, Phil. Trans. vol. lvi. part i. p. 163. has very justly observed, that the practice is brutal, destructive to friendship and moral sentiment, inconsistent with one great end of marriage, the education of children, and subversive of the natural rights of more than half of the species. Besides, it is injurious to population, and therefore can never be countenanced or allowed in a well-regulated state; for though the number of females in the world may considerably exceed the number of males, yet there are more men capable of propagating their species than women capable of bearing children; and it is a well-known fact, that Armenia, in which a plurality of wives is not allowed, abounds more with inhabitants than any other province of the Turkish empire.

† Heron's
Translation
of Niebuhr's
Travels.

‡ See Hin-
doo, ii. 9.

Indeed it appears, that in some countries where it is allowed, the inhabitants do not take advantage of it. "The Europeans (says M. Niebuhr †) are mistaken in thinking the state of marriage so different among the Mussulmans from what it is with Christian nations. I could not discern any such difference in Arabia. The women of that country seem to be as free and as happy as those of Europe can possibly be. Polygamy is permitted, indeed, among Mahometans, and the delicacy of our ladies is shocked at this idea; but the Arabians rarely avail themselves of the privilege of marrying four lawful wives, and entertaining at the same time any number of female slaves. None but rich voluptuaries marry so many wives, and their conduct is blamed by all sober men. Men of sense, indeed, think this privilege rather troublesome than convenient. A husband is by law obliged to treat his wives suitably to their condition, and to dispense his favours among them with perfect equality: but these are duties not a little disagreeable to most Mussulmans; and such modes of luxury are too expensive to the Arabians, who are seldom in easy circumstances. I must, however, except one case; for it sometimes happens that a man marries a number of wives in the way of commercial speculation. I know a Mullah, in a town near the Euphrates, who had married four wives, and was supported by the profits of their labour."

See a curious kind of polygamy under the article NAYRES. The ancient Britons, too, had a kind of polygamy among them, 12 women being common to 12 men.

Selden has proved, in his *Uxor Hebraica*, that plura-

lity of wives was allowed of, not only among the Hebrews, but also among all other nations, and in all ages. It is true, the ancient Romans were more severe in their morals, and never practised it, though it was not forbid among them: and Mark Antony is mentioned as the first who took the liberty of having two wives.

From that time it became pretty frequent in the empire till the reigns of Theodosius, Honorius, and Arcadius, who first prohibited it by express law in 393. After this the emperor Valentinian, by an edict, permitted all the subjects of the empire, if they pleased, to marry several wives; nor does it appear, from the ecclesiastical history of those times, that the bishops made any opposition to this introduction of polygamy. In effect, there are some even among the Christian casuists who do not look on polygamy as in itself criminal. Jurieu observes, that the prohibition of polygamy is a positive law; but from which a man may be exempted by sovereign necessity. Baillet adds, that the example of the patriarchs is a very powerful argument in favour of polygamy: of these arguments we shall speak hereafter.

It has been much disputed among the doctors of the civil law whether polygamy be adultery. In the Roman law it is called *stuprum*, and punished as such, that is, in some cases, capitally. But a smaller punishment is more consistent with the Jewish law, wherein the prohibition of adultery is perpetual, but that of polygamy temporary only.

In Germany, Holland, and Spain, this offence is differently punished. By a constitution of Charles V. it was a capital crime. By the laws of ancient and modern Sweden it is punished with death. In Scotland it is punished as perjury.

In England it is enacted by statute 1 Jac. I. cap. 11. that if any person, being married, do afterwards marry again, the former husband or wife being alive, it is felony, but within the benefit of clergy. The first wife in this case shall not be admitted as an evidence against her husband, because she is the true wife; but the second may, for she is indeed no wife at all; and so *vice versa* of a second husband. This act makes an exception to five cases, in which such second marriage, tho' in the three first it is void, is, however, no felony. 1. Where either party hath been continually abroad for seven years, whether the party in England had notice of the other's being living or not. 2. Where either of the parties hath been absent from the other seven years within this kingdom, and the remaining party hath had no notice of the other's being alive within that time. 3. Where there is a divorce or separation *a mensa et thoro* by sentence in the ecclesiastical court. 4. Where the first marriage is declared absolutely void by any such sentence, and the parties loosed *a vinculo*. Or, 5. Where either of the parties was under the age of consent at the time of the first marriage; for in such case the first marriage was voidable by the disagreement of either party, which this second marriage very clearly amounts to. But if at the age of consent the parties had agreed to the marriage, which completes the contract, and is indeed the real marriage, and afterwards one of them should marry again, judge Blackstone apprehends that such second marriage would be within the reason and penalties of the act.

Bernardus Ochinus, general of the order of Capuchins, and afterwards a Protestant, published, about the middle

Polygamy.

Polygamy. middle of the 16th century, Dialogues in favour of Polygamy, which were answered by Theodore Beza. And about the conclusion of the last century we had at London an artful treatise published in behalf of a plurality of wives, under the title of *Polygamia Triumphatrix*: the author whereof assumes the name of *Theophilus Aletheus*; but his true name was *Lyferus*. He was a native of Saxony. It has been answered by several.

A new argument in favour of polygamy has been adduced by Mr Bruce, on this principle, that in some parts of the world the proportion of female children is much greater than that of males. "From a diligent inquiry (says he) into the south and scripture-part of Mesopotamia, Armenia, and Syria, from Mouful or Nineveh to Aleppo and Antioch, I find the proportion to be fully two women to one man. There is indeed a fraction over, but it is not a considerable one. From Latikea, Laodicea *ad mare*, down the coast of Syria to Sidon, the number is nearly three, or two and three-fourths, to one man. Through the Holy Land, the country called *Horan*, in the Isthmus of Suez, and the parts of the Delta unfrequented by strangers, it is something less than three. But from Suez to the Straits of Babelmandel, which contains the three Arabias, the proportion is fully four women to one man; which I have reason to believe holds as far as the line, and 30° beyond it. The Imam of Sama was not an old man when I was in Arabia Felix in 1769; but he had 88 children then alive, of whom 14 only were sons. The priest of the Nile had 70 and odd children; of whom, as I remember, above 50 were daughters.

"It may be objected, that Dr Arbuthnot, in quoting the bills of mortality for 20 years, gave the most unexceptionable grounds for his opinion; and that my single assertion of what happens in a foreign country, without further foundation, cannot be admitted as equivalent testimony: and I am ready to admit this objection, as there are no bills of mortality in any of these countries. I shall therefore say in what manner I attained the knowledge which I have just mentioned. Whenever I went into a town, village, or inhabited place, dwelt long in a mountain, or travelled journeys with any set of people, I always made it my business to inquire how many children they had, or their fathers, their next neighbours or acquaintance. I then asked my landlord at Sidon, suppose him a weaver, how many children he has had? He tells me how many sons and how many daughters. The next I ask is a tailor, a smith, &c. in short every man who is not a stranger, from whom I can get the proper information. I say, therefore, that a medium of both sexes, arising from three or four hundred families, indiscriminately taken, shall be the proportion in which one differs from the other; and this, I am confident, will give the result to be three women in 50° of the 90° under every meridian of the globe."

Our author corroborates this argument by supposing that Mahomet perceived this disproportion, and that upon it he founded his institution allowing one man to have four wives. "With this view he enacted, or rather revived, the law which gave liberty to every individual to marry four wives, each of whom was to be equal in rank and honour, without any preference but what the predilection of the husband gave her."

Having thus established, as he supposes, the necessity

of polygamy in the East, Mr Bruce proceeds to consider whether there is not some other reasons why it should not be practised in Britain farther than the mere equality in numbers of the sexes to one another. This reason he finds in the difference between the constitutions of the Europeans and eastern nations. "Women in England (says he) are capable of child-bearing at 14; let the other term be 48, when they bear no more; 34 years therefore an English woman bears children. At the age of 14 or 15 they are objects of our love; they are endeared by bearing us children after that time; and none, I hope, will pretend, that at 48 and 50 an Englishwoman is not an agreeable companion. The Arab, on the other hand, if she begins to bear children at 11, seldom or never has a child after 20. The time, then, of her child-bearing is nine years; and four women, taken altogether, have then the term of 36. So that the English woman that bears children for 34 years has only two years less than the term enjoyed by the four wives whom Mahomet has allowed; and if it be granted that an English wife may bear at 50, the terms are equal. But there are other grievous differences. An Arabian girl, at 11 years old, by her youth and beauty, is the object of man's desire: being an infant, however, in understanding, she is not a rational companion for him. A man marries there, say at 20; and before he is 30, his wife, improved as a companion, ceases to be an object of his desires and a mother of children: so that all the best and most vigorous of his days are spent with a woman he cannot love; and with her he would be destined to live 40, or 45 years, without comfort to himself by increase of family, or utility to the public. The reasons, then, against polygamy, which subsist in England, do not by any means subsist in Arabia; and that being the case, it would be unworthy of the wisdom of God, and an unevenness in his ways, which we shall never see, to subject two nations under such different circumstances absolutely to the same observances."

To all this argumentation, however, it may be replied, that whatever we may now suppose to be the constitution of nature in the warmer parts of the globe, it certainly was different at the beginning. We cannot indeed ascertain the exact position of the Garden of Eden; but it is with reason supposed not to have been far from the ancient seat of Babylon. In that country, therefore, where Mr Bruce contends that four women are necessary to the comfort of one man, it pleased God to grant only one to the first man; and that, too, when there was more occasion for population than ever there has been since, because the whole earth was to be peopled from a single pair. Matters were not altered at the flood; for Noah had but one wife. And this is the very argument used by our Saviour himself when speaking of divorce without any sufficient cause, and then marrying another woman, which is a species of polygamy.—Again, with respect to the alleged multiplicity of females in the eastern part of the world, it is by no means probable that the calculations of Mr Bruce or any other person can be admitted in this case. History mentions no such thing in any nation; and considering the vast destruction among the male part of the human species more than of the females by war and other accidents, we may safely say, that if four women children were born for every single male, there would
in

Polygamy.

Polygamy in such countries be five or six grown up women for every man; a proportion which we may venture to affirm does not, nor ever did, exist anywhere in the world. That it was not so in former times we can only judge from the particular examples recorded in history, and these are but few. We read in the Greek history, indeed, of the *fifty* daughters of Danaus; but these were matched by as many *sons* of another man. Job had only one wife, yet had *seven* sons and but *three* daughters. Jacob had two wives, who bore *twelve* sons, and only one daughter. Abraham had only one child by his first wife, and that was a son. By his second wife Keturah he had six sons; and considering his advanced age at the time he married her, it is by no means probable that he could have 24 daughters; nay, if, as Mr Bruce tells us, the women in the eastern countries bear children only for nine years, it was impossible she could have so many. Gideon, who had many wives, had no fewer than seventy sons by these wives, and even his concubine had a son; so that if all these women had produced according to Mr Bruce's proportion, of nearly three females to one male, he must have had almost 284 children; a better family than any of Mr Bruce's eastern acquaintances can probably boast of.

With regard to this subject, however, it must be observed, that the procreation of male or female children depends in some degree on the health and vigour of the parents. It is by no means improbable, therefore, that the eastern voluptuaries, whose constitutions are debilitated by their excesses, may have many more female than male children born to them. The women themselves, by premature enjoyment, will also be inclined to produce females instead of males; but neither of these circumstances can prove this to be an original law of nature. Something like this may be gathered from sacred history. Gideon above-mentioned, who was a hardy and active warrior, had many sons. The same was the case with David, who led an active and laborious life; while Solomon, who was a voluptuary, had only one son, notwithstanding his multitude of wives.

The most barefaced defence of polygamy that has appeared in modern times is by the Rev. Mr Madan, who published a treatise, artfully vindicating, and strongly recommending it, under the title of *Thelyphthora*; or, *A treatise on Female Ruin, in its Causes, Effects, Consequences, Prevention, and Remedy*, &c. Marriage, according to this writer, simply and wholly consists in the act of personal union, or *actus coitus*. Adultery, he says, is never used in the sacred writings but to denote the defilement of a betrothed or married woman, and to this sense he restricts the use of the term; so that a married man, in his opinion, is no adulterer, if his commerce with the sex be confined to single women, who are under no obligations by espousals or marriage to other men: but, on the other hand, the woman who should dare to have even but once an intrigue with any other man besides her husband, (let him have as many wives as Solomon), would, *ipso facto*, be an adulteress, and ought, together with her gallant, to be punished with immediate death. This, he boldly says, is the law of God: and on this foundation he limits the privilege of polygamy to the man; in support of which he refers to the polyga-

mous connections of the patriarchs and saints of the **Polygamy** Old Testament, and infers the lawfulness of their practice from the blessings which attended it, and the laws which were instituted to regulate and superintend it. He contends for the lawfulness of Christians having, like the ancient Jews, more wives than one; and labours much to reconcile the genius of the evangelical dispensation to an arrangement of this sort. With this view he asserts, that there is not one text in the New Testament that even hints at the criminality of a polygamous connection; and he would infer from St Paul's direction, that bishops and deacons should have but one wife, that it was lawful for laymen to have more. Christ, he says, was not the giver of a new law; but the business of marriage, polygamy, &c. had been settled before his appearance in the world, by an authority which could not be revoked. Besides, this writer not only thinks polygamy lawful in a religious, but advantageous in a civil, light, and highly politic in a domestic view.

In defence of his notion of marriage, which, he says, consists in the union of man and woman as one body, the effects of which in the sight of God no outward forms or ceremonies of man's invention can add to or detract from, he grounds his principal argument on the Hebrew words made use of in Gen. ii. 24. to express the primitive institution of marriage, viz. *רבק באשה*, rendered by the LXX. *προσπολινησεται προς την γυναικα αυτην*, which translation is adopted by the evangelist (Mat. xix. 5.) with the omission only of the superfluous preposition (*προς*) after the verb. Our translation, "shall cleave to his wife," doth not, he says, convey the idea of the Hebrew, which is literally, as Montanus renders the words, "shall be joined or cemented in his woman, and they shall become (*i. e.* by this union) one flesh." But on this criticism it is well remarked, that both the Hebrew and Greek terms mean simply and literally attachment or adherence; and are evidently made use of in the sacred writings to express the whole scope of conjugal fidelity and duty, though he would restrain them to the grosser part of it.

With respect to the Mosaic law, for which Mr Madan is a warm advocate, it was certainly a local and temporary institution, adapted to the ends for which it was appointed, and admirably calculated, in its relation to marriage, to maintain and perpetuate the separation of the Jewish people from the Gentiles. In attempting to depreciate the outward forms of marriage, this writer would make his readers believe, that because none are explicitly described, therefore none existed; and consequently that they are the superfluous ordinances of human policy. But it is evident, from comparing Ruth iv. 10, 13. with Tobit vii. 13, 14. and from the case of Dinah, related Gen. xxxiv. that some forms were deemed essential to an honourable alliance by the patriarchs and saints under the Old Testament, exclusive of the carnal knowledge of each other's persons. It is also evident in the case of the woman of Samaria, whose connection with a man not her husband is mentioned in John iv. that something besides cohabitation is necessary to constitute marriage in the sight of God.

Having stated his notion of marriage, he urges, in defence of polygamy, that, notwithstanding the seventh commandment, it was allowed by God himself, who

Polygamy, who made laws for the regulation of it, wrought miracles in support of it by making the barren woman fruitful, and declared the issue legitimate to all intents and purposes. God's allowance of polygamy is argued from Exod. xxi. 10. and particularly from Dent. xxi. 15. which, he says, amounts to a demonstration. This passage, however, at the utmost, only presupposes that the practice might have existence among so hard-hearted and fickle a people as the Jews; and therefore wisely provides against some of its more unjust and pernicious consequences, such as tended to affect the rights and privileges of heirship. Laws enacted to regulate it cannot be fairly urged in proof of its lawfulness on the author's own hypothesis; because laws were also made to regulate divorce, which Mr Madan condemns as absolutely unlawful, except in cases of adultery. Besides, it is more probable that the "bated wife" had been dismissed by a bill of divorce, than that she was retained by her husband: and moreover, it is not certain but that the two wives, so far from living with the same husband at the same time, might be dead; for the words may be rendered thus, "if there *should have been* to a man two wives, &c." The words expressing the original institution of marriage, Gen. ii. 24. compared with Mat. xix. 4, 5, 8. afford insuperable objections against Mr Madan's doctrine of polygamy.

If we appeal on this subject, from the authority of Scripture to the writings of the earliest fathers in the Christian church, there is not to be found the faintest trace of any thing resembling a testimony to the lawfulness of polygamy; on the contrary, many passages occur, in which the practice of it is strongly and explicitly condemned.

We shall close this article with the words of an excellent anonymous writer already quoted, and to whose critique on Mr Madan's work we are indebted for the above remarks: "In a word, when we reflect that the primitive institution of marriage limited it to one man and one woman; that this institution was adhered to by Noah and his sons, amidst the degeneracy of the age in which they lived, and in spite of the examples of polygamy which the accursed race of Cain had introduced; when we consider how very few (comparatively speaking) the examples of this practice were among the faithful; how much it brought its own punishment with it; and how dubious and equivocal those passages are in which it appears to have the sanction of divine approbation; when to these reflections we add another, respecting the limited views and temporary nature of the more ancient dispensations and institutions of religion—how often the imperfections and even vices of the patriarchs and people of God, in old time, are recorded, without any express notification of their criminality—how much is said to be commanded, which our reverence for the holiness of God and his law will only suffer us to suppose, were, for wise ends, permitted—how frequently the messengers of God adapted themselves to the genius of the people to whom they were sent, and the circumstances of the times in which they lived:—above all, when we consider the purity, equity, and benevolence of the Christian law; the explicit declarations of our Lord, and his apostle St Paul, respecting the institution of marriage, its design and limita-

tion;—when we reflect, too, on the testimony of the most ancient fathers, who could not possibly be ignorant of the general and common practice of the apostolic church; and, finally, when to these considerations we add those which are founded on justice to the female sex, and all the regulations of domestic economy and national policy—we must wholly condemn the revival of polygamy; and thus bear our honest testimony against the leading design of this dangerous and ill-advised publication."

We would advise our readers to read the whole criticisms on Madan's book in the Monthly Review, together with their account of the several answers to it. The reverend author of the Thelyphthora has there met with a most able antagonist, who traces him through all his deceitful windings, and exposes the futility and falsehood of his arguments with singular ability. See *Monthly Review*, vol. lxiii. p. 273, &c.; see also *Paley's Moral Philosophy*, 4to. p. 262.

POLYGARS, are natives of Hindostan. They inhabit almost impenetrable woods, and are under the absolute direction of their own chieftains. In time of peace they are professionally robbers, but in times of war are the guardians of the country. The general name of these people is *Polygar*. Their original institution, for they live in distinct clans, is not very well understood. It probably took its rise from the municipal regulations relative to the destruction of tygers and other ferocious beasts. Certain tracts of woodland were indisputably allotted as rewards to those who should slay a certain number of those animals; and those lands approximating, probably laid the foundation of the several confederacies of Polygars.

"The Pollams, or woods, from which is derived the word *Polygar*, lying in profusion through all the southern parts of Hindostan, the ravages committed in the open countries by these adventurous clans, are both frequent and destructive. Cattle and grain are the constant booty of the Polygars. They not unfrequently even despoil travellers of their property, and sometimes murder, if they meet with opposition: yet these very Polygars are the hands into which the aged and infirm, the wives, children, and treasure, of both Hindoos and others are entrusted, when the circumjacent country unfortunately happens to be the seat of war. The protection they afford is paid for; but the price is inconsiderable, when the helpless situation of those who fly to them for shelter is considered, and especially when their own very peculiar character is properly attended to. The native governments of Hindostan are under the necessity of tolerating this honourable banditti. Many of them are so formidable as to be able to bring 15,000 and 20,000 men into the field.

"The Hindoo code of laws, in speaking of robberies, hath this remarkable clause, 'The mode of shares amongst robbers shall be this:—If any thief or thieves, by the command of the magistrate, and with his assistance, have committed depredations upon, and brought away any booty from, another province, the magistrate shall receive a share of one sixth part of the whole. If they received no command or assistance from the magistrate, they shall give the magistrate in that case one tenth part for his share, and of the remainder their chief shall receive four shares; and whosoever

Polygars
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Polygno-
tus.

among them is perfect master of his occupation, shall receive three shares: also, whichever of them is remarkably strong and stout, shall receive two shares, and the rest shall receive each one share.' Here, then, we see not only a sanction, but even an inducement, to fraudulent practices.—Another singular inconsistency among a people who, in many periods of their history, have been proverbial for innocency of manners, and for uncommon honesty in their conduct towards travellers and strangers.

"At the first sight, it would appear that the toleration of the Polygars, owing to their great numbers, and to the security of their fortresses, which are in general impenetrable but to Polygars; that the government licence, in this manner given to them, to live on the spoils of the industrious—might have originally occasioned the formal division, and encouragement to perseverance, which we have just quoted: but the cause I should rather suppose to lie in the nature of certain governments, than to have arisen from any accidental circumstance afterwards; and I am the more inclined to this opinion, from the situation of the northern parts of Hindostan, which are, and always have been, uninfested by these freebooters.

"The dominion of the East was, in former days, most probably divided and subdivided into all the various branches of the feudal system. The vestiges of it remain to this hour: rajahs and zemindars are nothing more than chieftains of a certain degree of consequence in the empire. If, then, experience has shown, in other parts of the world, that clans have always been observed to commit the most pernicious acts of depredation and hostility on each other, and that the paramount lord has seldom been able effectually to crush so general and so complicated a scene of mischief—may we not reasonably venture to suppose, that the Hindoo legislature passed this ordinance for the suppression of such provincial warfare, and for the wholesome purpose of drawing the people, by unalarming degrees, more immediately under the controul of the one sovereign authority? The conclusion, I own, appears to me satisfactory. Moreover, Polygars cannot but be of modern growth; for the law relative to thefts is antecedent to the mention of Polygars in history." Sullivan's *Philosophical Rhapsodies*.

POLYGLOTT, among divines and critics, chiefly denotes a Bible printed in several languages. See BIBLE and PRINTING.

POLYGLOTTUS, in ornithology. See TURDUS.

POLYGNOTUS, a famous painter of Thasos, flourished about 422 years before the Christian era, and was the son and scholar of Aglaophon. He adorned one of the public porticoes of Athens with his paintings, in which he had represented the most striking events of the Trojan war. The Athenians were so pleased with him, that they offered to reward his labours with whatever he pleased to accept; but he declined the offer; and the Amphictyonic council, which was composed of the representatives of the principal cities of Greece, ordered that Polygnotus should be maintained at the public expence wherever he went.

Of the talents of Polygnotus much honourable mention is made by many of the best authors of antiquity, as Aristotle and Plutarch, Dionysius Halicarnassensis, Vol. XV. Part I.

&c. Pausanias speaks of his pictures of the events of the Trojan war, and, in his Tenth Book, introduces a very long description of other pictures by the same artist, painted also from Homer in the temple at Delphos. The passage, however, gives but a confused and imperfect idea of the painter's performance. How much the art is indebted to this ancient master, what grace and softness he gave to the human countenance, what embellishments he added to the female figure and dress, are much more happily described by Pliny. "Primus mulieres lucida veste pinxit, capita earum mitris versicoloribus operuit, plurimumque picturæ primus contulit: siquidem instituit os adaperire, dentes ostendere, vultum ab antiquo rigore variare."—The same author likewise bears honourable testimony to the liberal spirit of this great artist, who refused any reward for his ingenious labours in the portico.—"Porticum gratuito, cum partem ejus Mycon mercede pingeret." Plin. lib. 35. cap. 8.

POLYGON, in geometry, a figure with many sides, or whose perimeter consists of more than four sides at least; such are the pentagon, hexagon, heptagon, &c.

POLYGONUM, KNOT-GRASS: A genus of the trigynia order, belonging to the octandria class of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. There is no calyx; the corolla is quinquepartite, and calycine, or serving instead of a calyx; there is one angulated seed. There are 27 species; but the most remarkable are, 1. The bistorta, bistort, or greater snakeweed, hath a thick oblique intorted root, blackish without, and red within; a simple, round, slender stem, near two feet high; oval leaves, having decurrent foot-stalks, and the stalk terminated by thick short spikes of whitish-red flowers. 2. The viviparum, or smaller bistort, hath a thickish root, a simple slender stem half a foot high, spear-shaped leaves, and the stalks and branches terminated by long spikes of whitish-red flowers. Both these perennials flower in May and June, succeeded by ripe seeds in August. They grow wild in England, &c. the first in moist, the other in mountainous, situations. 3. Oriental polygonum, commonly called *perficaria*, hath fibrous roots; an upright, robust, strong, jointed stem, rising eight or ten feet high, dividing at top into several branches; very large oval-lanceolate alternate leaves, on broad footstalks half surrounding the stem; and all the branches terminated by long, slender, hanging spikes of reddish-purple heptandrous and digynious flowers, from July till October. 4. Fagopyrum, buckwheat, or brank, rises with an upright, smooth, branchy stem, from about a foot and a half to a yard high, heart-shaped sagittated leaves, and the branches terminated by clusters of whitish flowers, succeeded by large angular seeds; excellent for feeding pigeons and most sorts of poultry.

All these plants are hardy, and succeed in almost any soil and situation; the two first are perennial in root; and the third and fourth are annual, wholly decay at the end of summer, or early in winter. The first two sorts are retained in some curious gardens for variety; but their chief merit is for medical purposes; they are powerful astringents, and are used both internally and externally; esteemed very efficacious in hæmorrhages and other fluxes; and good to heal sore mouths. The third sort, Oriental polygonum, or *perficaria*, is a most elegant

Polygon,
Polygo-
num.

Polygo-
num
||
Polyhe-
dron.

elegant annual for the embellishment of pleasure-ground; assuming a majestic tree-like growth by its erect luxuriant stem, and branchy head; which being garnished with noble large foliage, and numerous pendulous spikes of flowers, in constant succession three or four months, exhibits a very ornamental appearance from June or July until October, and is so easy of culture, that from its scattered seeds in autumn, young plants rise spontaneously in abundance the ensuing spring, and shoot up so rapidly as to attain six or eight feet in height by July, when they generally begin flowering, and continue till attacked by the frost, when they totally perish; so that a fresh supply must be raised from seed annually. The fourth sort (buck-wheat) is a sort of corn, and is frequently cultivated both by way of fodder, cutting its stalks while young and green to feed cattle, and for its grain to feed pigeons, poultry, hogs, &c. It flourishes in any soil and situation, but generally thrives best in a light dry earth; and the driest seasons seldom retard its growth. The first and second sorts are easily propagated in plenty, by parting the roots in autumn. The third sort, Oriental polygonum, being annual, is always propagated from seed annually, either in the full ground, or by means of hot-beds.

Uses. The root of a kind of bistort, according to Gmelin, is used in Siberia for ordinary food. This species is by Haller called *bistorta foliis ad oram nervosis*, and by some other botanists *bistorta montana minor*. The natives call it *mouka*; and so indolent are they, that, to save themselves the trouble of digging it out of the earth, they go in spring and pillage the holes of the mountain rats, which they find filled with these roots. In our country, bistort is used as a medicine. All the parts of bistort have a rough austere taste, particularly the root, which is one of the strongest of the vegetable astringents. It is employed in all kinds of immoderate hæmorrhagies and other fluxes, both internally and externally, where astringency is the only indication. It is certainly a very powerful styptic, and is to be looked on simply as such; the sudorific, antipestifential, and other like virtues ascribed to it, it has no other claim to than in consequence of its astringency, and of the antiseptic power which it has in common with other vegetable styptics. The largest dose of the root in powder is a single dram.

POLYGRAPHY, **POLYGRAPHIA**, or *Polygraphice*, the art of writing in various unusual manners or ciphers; as also of deciphering the same. The word is formed from the Greek, *πολυ*, *multum*, and *γραφη*, *scriptura*, "writing."

The ancients seem to have been very little acquainted with this art; nor is there any mark of their having gone beyond the Lacedæmonian scytala. Trithemius, Porta, Vigenere, and father Nicéron, have written on the subject of polygraphy or ciphers. See **CIPHER**.

POLYHYMNIA, in the pagan mythology, one of the nine muses, thus named from the Greek words *πολυς* "much," and *μνησις* "memory." She presided over history, or rather rhetoric; and is represented with a crown of pearls and a white robe; her right hand in action as if haranguing, and holding in her left a caduceus or sceptre to show her power.

POLYHEDRON, in geometry, denotes a body or solid comprehended under many sides or planes.

POLYHEDRON, in optics, is a multiplying glass or

lens, consisting of several plane surfaces disposed into a Polymathy convex form. See **OPTICS**, n° 256.

POLYMATHY, denotes the knowledge of many arts and sciences. The word is derived from the Greek, *πολυ*, *multum*, and *μαθαινα*, *disco*. ||
Polyphe-
mus.

POLYMNESTOR, was a king of the Thracian Chersonesus. He married Ilione, Priam's eldest daughter; and for the sake of the treasure with which he was entrusted by Priam during the siege of Troy, he murdered Polydorus, (see **POLYDORUS**). The fleet in which the victorious Greeks returned, together with their Trojan captives, among whom was Hecuba, stopped on the coasts of Thrace, where one of the female captives discovered on the shore the body of Polydorus, whom Polymnestor had thrown into the sea. The dreadful intelligence was immediately communicated to Hecuba his mother, who recollecting the frightful dreams she had the preceding night, did not doubt but Polymnestor was the cruel assassin. Resolved to revenge her son's death, she immediately called out Polymnestor, as if to impart to him something of importance. He was drawn into the snare; and no sooner was he introduced into the apartment of the Trojan princess, than the female captives rushing upon him, put out his eyes with their pins, while Hecuba murdered his two children, who had accompanied him. Euripides informs us, that the Greeks condemned Polymnestor to be banished into a distant island for his perfidy. Hyginus, however, relates the whole differently, and tells us, that when Polydorus was sent to Thrace, Ilione his sister took him instead of her son Deiphilus, who was of the same age, being fearful of her husband's cruelty. The monarch, unacquainted with the imposition, looked upon Polydorus as his own son, and treated Deiphilus as her brother. After the destruction of Troy, the conquerors wished the house and family of Priam to be extirpated, and therefore offered Electra the daughter of Agamemnon to Polymnestor, if he would destroy Ilione and Polydorus. He accepted the offer, and immediately dispatched his own son Deiphilus, whom he took for Polydorus. Polydorus, who passed as the son of Polymnestor, consulted the oracle after the murder of Deiphilus, and being informed that his father was dead, his mother a captive in the hands of the Greeks, and his country in ruins, he communicated the answer to Ilione, whom he had always regarded as his mother. She told him the measures she had pursued to save his life, upon which he avenged the perfidy of Polymnestor by putting out his eyes.

POLYMNIA, in botany: A genus of the polygamia necessaria order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, *Composita*. The receptacle is paleaceous; there is no pappus; the exterior calyx is tetraphyllous, or pentaphyllous; the interior decaphyllous, and composed of concave leaflets.

POLYNICES, the son of Œdipus by his mother Jocasta. See **JOCASTA**, **ŒDIPUS**, and **ETEOCLES**.

POLYPE. See **POLYPUS**.

POLYPETALOUS, among botanists, an epithet applied to such flowers as consist of several petals or flower-leaves.

POLYPHEMUS (fab. hist.), a celebrated Cyclops, and king of all the Cyclops in Sicily, was the son of Neptune and Thoosa the daughter of Phorcys. He is said to have been a monster of great strength, very tall, and

Polypodium.

and with one eye in the middle of the forehead. He eat human flesh, and kept his flocks on the coasts of Sicily, when Ulysses, at his return from the Trojan war, was driven there. Ulysses, together with 12 of his companions, visited the coast, and with them was seized by the Cyclops, who confined them in his cave, and daily devoured two of them. Ulysses would have shared the fate of the rest, had he not intoxicated the Cyclops, and put out his eye with a firebrand when he was asleep. Polyphemus was awakened by the sudden pain, and stopped the entrance of his cave; but Ulysses escaped, by creeping between the legs of the rams of the Cyclops, as they were led out to feed on the mountains. Polyphemus became enamoured of Galatæa; but his addresses were disregarded, and the nymph shunned his presence. The Cyclops was still more earnest; and when he saw Galatæa surrender herself to the pleasures of Acis, he crushed his rival with a piece of a broken rock.

POLYPODIUM, in botany; a genus of the order of filices, belonging to the cryptogamia class of plants. The fructifications are in roundish points, scattered over the inferior disc of the frons or leaf.—There are 65 species, of which the most remarkable is the filix mas, or common male fern. This grows in great plenty throughout Britain in woods and stony uncultivated soils. The greatest part of the root lies horizontally, and has a great number of appendages placed close to each other in a vertical direction, while a number of small fibres strike downwards. The leaves are a cubit high, and grow in circular tufts. They are at first alternately pinnate, the pinnæ increasing in size from the base towards the middle, and afterwards gradually decreasing upwards to the summit of the leaf. These pinnæ are again pinnatifid, or subdivided almost to the nerve into obtuse parallel lobes, crenated on the edges. The stalks are covered with brown filmy scales. The fructifications are kidney-shaped, and covered with a permanent scaly shield or involucre. The capsules are of a pale brown, surrounded with a saffron-coloured elastic ring.

This fern has nearly the same qualities, and is used for most of the same intentions, as the pteris aquilina. They are both burnt together for the sake of their ashes, which are purchased by the soap and glass-makers. In the island of Jura are exported annually 150 l. worth of these ashes.

Gunner relates, in his *Flor. Norveg.* that the young curled leaves, at their first appearance out of the ground, are by some boiled and eaten like asparagus; and that the poorer Norwegians cut off those succulent laminæ, like the nails of the finger at the crown of the root, which are the bases of the future stalks, and brew them into beer, adding thereto a third portion of malt, and in times of great scarcity mix the same in their bread. The same author adds, that this fern cut green, and dried in the open air, affords not only an excellent litter for cattle, but, if infused in hot water, becomes no contemptible fodder to goats, sheep, and other cattle, which will readily eat and sometimes grow fat upon it: a circumstance well worth the attention of the inhabitants of the Highlands and Hebrides, as great numbers of their cattle, in hard winters, frequently perish for want of food.

But the anthelmintic quality of the root of the male fern is that for which it is chiefly to be valued, and of

which an account is given under the article **MEDICINE**, *Polypodium*, p. 343. col. 2.

The *polypodium oreopteris* is only remarkable because it has been confounded by most of the English botanists with the species which we have now described, and the *polypodium thelypteris*. It has a large scaly root, wrapped and tied together with small strong fibres, not to be separated without difficulty.—The fructifications are on the margins both when young and old, and never run into one another: the lobes are oval and plain. It is four times as large as the *thelypteris*, and grows in dry woods, moors, or hills, and very seldom near water; all which characters are widely different from those of the species with which it has been confounded. It is to be found both in England and Scotland, in the latter place very plentifully. See *Linnean Transactions*, vol. i. p. 181.

POLYPREMUM, in botany: A genus of the monogynia order, belonging to the tetrandria class of plants; and in the natural method ranking under the 22d order, *Caryophyllei*. The calyx is tetraphyllous; the corolla quadrifid and rotaceous, with its lobes obcordate; the capsule compressed, emarginated, and bilocular.

POLYPUS, a species of fresh-water insects, belonging to the genus of hydra, of the order of zoophytes, and class of vermes. (See *ANIMALCULE*, n° 24, &c.) The name of *hydra* was given them by Linnæus on account of the property they have of reproducing themselves when cut in pieces, every part soon becoming a perfect animal. Dr Hill called them *biota*, on account of the strong principle of life with which every part of them is endowed.

These animals were first discovered by Leeuwenhoek, who gave some account of them in the Philosophical Transactions for 1703; but their wonderful properties were not thoroughly known till the year 1740, when Mr Trembley began to investigate them. Previous to his discoveries, indeed, Leibnitz and Boerhaave, by reasonings *à priori*, had concluded that animals might be found which would propagate by slips like plants; and their conjectures were soon verified by the observations of the gentleman above-mentioned. At first, however, Mr Trembley was uncertain whether he should reckon these creatures animals or plants; and while thus uncertain, he wrote a letter on the subject to Mr Bonnet in January 1741; but in March the same year he had satisfied himself that they were real animals. The surprise of Mr Trembley, and of others, on discovering the true nature of these animals, was very great. When Mr Reaumur saw for the first time two polypes formed from one which he had divided into two parts, he could hardly believe his own eyes; and even after having repeated the operation an hundred times, he said that the sight was by no means familiar to him. On the 18th of July 1741, M. Buffon wrote to Martin Folkes, Esq; president of the Royal Society, acquainting him with “the discovery of a small insect called a *polypus*, which is found about the common duck-weed; and which, being cut in two, puts forth from the upper part a tail, and from the lower end a head, so as to become two animals instead of one. If it be cut into three parts, the middlemost also puts out from one end a head, and from the other a tail, so as to become three distinct animals, all living like the first, and performing the various offices of their species.”

Polypodium.
Polypus.

Polypus. species."—In September the same year, a letter was communicated from C. Bentink, Esq; at the Hague, describing the insects discovered by Mr Trembley, adding, that he himself had seen them; and in November that year, a letter was read before the Society from Gronovius at Leyden, giving an account of a water-insect, which, says he, if cut into five or six pieces, in a few hours there will be as many animals exactly similar to their parent. These accounts, however, were all deemed so extraordinary, that they were not credited, until professors Albinus and Muschenbroeck provided themselves with them, and found every thing related concerning them to be exactly true. In March 1742, Mr Folkes gave an account of them to the Royal Society, from some observations made on several polypes which Mr Trembley had sent from Holland. They were soon after found in England, and the observations made upon them were published by several persons; so that no doubt remained concerning the reality of what had been related concerning them.

The general character of the polype is, that it fixes itself by its base; is gelatinous, linear, naked, contractile; and can change its place. The mouth, which is placed at one end, is surrounded by hair-like feelers. The young ones grow out from its sides; but in autumn it produces eggs from its sides. There are six varieties.

1. The *viridis*, or green polype, has commonly ten short arms.

2. The *fusca* has frequently eight arms several times longer than the body.

3. The *grisea* is of a yellowish colour, small towards the bottom, and has long arms, generally about seven in number.

4. The *pallens* has generally about six arms of a moderate length.

5. The *hydatula* has a vesicular body, and four obsolete arms. It is found in the abdomen of sheep, swine, &c.

6. The *stentorea* has been called the *tunnel-shaped*, and has a mouth surrounded with a row of hairs.

7. The *socialis* is bearded, thick, and wrinkled.

The three first species are those on which the greatest number of experiments have been made; and their shapes are so various, that it is by no means easy to describe them. They are generally found in ditches. Whoever has carefully examined these when the sun is very powerful, will find many little transparent lumps of the appearance of a jelly, and size of a pea, and flattened upon one side. The same kind of substances are likewise to be met with on the under side of the leaves of plants which grow in such places. These are the polypes in a quiescent state, and apparently inanimate. They are generally fixed by one end to some solid substance, with a large opening, which is the mouth, at the other; having several arms fixed round it, projecting as rays from the centre. They are slender, pellucid, and formed of a tender substance like the horns of a snail, and capable of contracting themselves into a very small compass, or of extending to a considerable length. The arms are capable of the same contraction and expansion as the body; and with these they lay hold of minute worms and other insects, bringing them to the mouth and swallowing them; the indigestible parts are again thrown out by the mouth.

The green polype was that first discovered by Mr Trembley; and the first appearances of spontaneous motion were perceived in its arms, which it can contract, extend, and twist about in various directions. On the first appearance of danger they contract to such a degree that they appear little bigger than a grain of sand, of a fine green colour, the arms disappearing entirely. Soon after he found the *grisea*, and afterwards the *fusca*.

The bodies of the *viridis* and *grisea* diminish almost insensibly from the anterior to the posterior extremity; but the *fusca* is for the most part of an equal size for two-thirds of its length from the anterior to the posterior extremity, from which it becomes abruptly smaller, and then continues of a regular size to the end. These three kinds have at least six, and at most 12 or 13 arms, though sometimes the *grisea* is met with having 18 arms. They can contract themselves till their bodies do not exceed one-tenth of an inch in length, and they can stop at any intermediate degree of contraction or extension. They are of various sizes, from half an inch to an inch and an half long; their arms are seldom longer than their bodies, though some have them an inch, and some even eight inches, long. The thickness of their bodies decreases as they extend themselves, and *vice versa*; and they may be made to contract themselves either by agitating the water in which they are contained, or by touching the animals themselves. When taken out of the water, they all contract so much that they appear only like a little lump of jelly. The arms have the same power of contraction or expansion that the body has; and they can contract or expand one arm, or any number of arms, independent of the rest; and they can likewise bend their bodies or arms in all possible directions. They can also dilate or contract their bodies in various places, and sometimes appear thick set with folds, which, when carelessly viewed, appear like rings. Their progressive motion is performed by that power which they have of contracting and dilating their bodies. When about to move, they bend down their head and arms, lay hold by means of them on some other substance to which they design to fasten themselves; then they loosen their tail, and draw it towards the head; then either fix it in that place, or stretching forward their head as before, repeat the same operation. They ascend or descend at pleasure in this manner upon aquatic plants, or upon the sides of the vessel in which they are kept; they sometimes hang by the tail from the surface of the water, or sometimes by one of the arms; and they can walk with ease upon the surface of the water. On examining the tail with a microscope, a small part of it will be found to be dry above the surface of the water, and as it were in a little concave space, of which the tail forms the bottom; so that it seems to be suspended on the surface of the water on the same principle that a small pin or needle is made to swim. When a polype, therefore, means to pass from the sides of the glass to the surface of the water, it has only to put that part out of the water by which it is to be supported, and to give it time to dry, which it always does upon these occasions; and they attach themselves so firmly by the tail to aquatic plants, stones, &c. that they cannot be easily disengaged: they often further strengthen these attachments by means

Polypus.

means of one or two of their arms, which serve as a kind of anchors for fixing them to the adjacent substances.

The stomach of the polype is a kind of bag or gut into which the mouth opens, and goes from the head to the tail. This, in a strong light, is visible to the naked eye, especially if the animal be placed between the eye and a candle; for these animals are quite transparent whatever their colour may be. The stomach, however, appears to more advantage through a powerful magnifier. Mr Trembley, by cutting one of these animals transversely into three parts, satisfied himself that they were perforated throughout. Each piece immediately contracted itself, and the perforation was very visible through a microscope. The skin which incloses the stomach is that of the polype itself; so that the whole animal, properly speaking, consists only of one skin, in the form of a tube, and open at both ends. No vessels of any kind are to be distinguished.

The mouth is situated at the anterior end in the middle between the shooting forth of the arms, and assumes different appearances according to circumstances; being sometimes lengthened out in the form of a nipple, at others appearing truncated; sometimes the aperture is quite closed, at others there is a hollow; though at all times a small aperture may be discovered by a powerful magnifier.

The skin of a polype, when examined with a microscope, appears like shagreen, or as if covered with little grains, more or less separated from each other, according to the degree of contraction of the body. If the lips of a polype be cut transversely, and placed so that the cut part of the skin may lie directly before the microscope, the skin throughout its whole thickness will be found to consist of an infinite number of grains, and the interior part is found to be more shagreened than the exterior one; but they are not strongly united to each other, and may be separated without much trouble. They even separate of themselves, though in no great numbers, in the most healthy animals of this kind; for where they are observed to separate in large quantities, it is a symptom of a very dangerous disorder. In the progress of this disorder, the surface of the polype becomes gradually more and more rough and unequal, and no longer well defined or terminated as before. The grains fall off on all sides; the body and arms contract and dilate, and assume a white shining colour; and at last the whole dissolves into an heap of grains, which is more particularly observed in the green polype. By a careful examination we find, that the skin of the polype is entirely composed of grains, cemented by means of a kind of gummy substance; but it is to the grains entirely that the polype owes its colour. The structure of the arms is analogous to that of the body; and they appear shagreened when examined by the microscope, whether they be in a state of contraction or extension; but if very much contracted, they appear more shagreened than the body, though almost quite smooth when in their utmost state of extension. In the green polype the appearance of the arm is continually varying; and these variations are more sensible towards the extremity of the arm than at its origin, but more scattered in the parts further on. The extremity is often terminated by a knob, the hairs of which cannot be observed without a very powerful mag-

nifier. They have a remarkable inclination of turning towards the light; so that if that part of the glass on which they are be turned from the light, they will quickly remove to the other.

That species named the *fusca* has the longest arms, and makes use of the most curious manœuvres to seize its prey. They are best viewed in a glass seven or eight inches deep, when their arms commonly hang down to the bottom. When this, or any other kind, is hungry, it spreads its arms in a kind of circle to a considerable extent, inclosing in this, as in a net, every insect which has the misfortune to come within the circumference. (See ANIMALCULE, n° 27.) While the animal is contracted by seizing its prey, the arms are observed to swell like the muscles of the human body when in action. Though no appearance of eyes can be observed in the polype, they certainly have some knowledge of the approach of their prey, and show the greatest attention to it as soon as it comes near them. It seizes a worm the moment it is touched by one of the arms; and in conveying it to the mouth, it frequently twists the arm into a spiral like a corkscrew; by which means the insect is brought to the mouth in a much shorter time than otherwise it would be; and so soon are the insects on which the polypes feed killed by them, that M. Fontana thinks they must contain the most powerful kind of poison; for the lips scarce touch the animal when it expires, though there cannot be any wound perceived on it when dead. The worm, when swallowed, appears sometimes single, sometimes double, according to circumstances. When full, the polype contracts itself, hangs down as in a kind of stupor, but extends again in proportion as the food is digested and the excrementitious part is discharged. The bodies of the insects, when swallowed, are first macerated in the stomach, then reduced into fragments, and driven backward and forward from one end of the stomach to the other, and even into the arms, however fine they may be; whence it appears that the arms, as well as the other parts of this remarkable creature, are a kind of hollow guts or stomachs. In order to observe this motion, it is best to feed the polypes with such food as will give a lively colour; such, for instance, as those worms which are furnished with a red juice. Some bits of a small black snail being given to a polype, the substance of the skin was soon dissolved into a pulp consisting of small black fragments; and on examining the polype with a microscope, it was found that the particles were driven about in the stomach, and that they passed into the arms, from thence back into the stomach, then to the tail; from whence they passed again into the arms, and so on. The grains of which the body of the polype consist take their colour from the food with which it is nourished, and become red or black as the food happens to afford the one colour or the other. They are likewise more or less tinged with these colours in proportion to the strength of the nutritive juices; and it is observable that they lose their colour if fed with aliments of a colour different from themselves. They feed on most insects found in fresh water; and will also be supported with worms, the larvæ of gnats, &c. and even with snails, large aquatic insects, and fish or flesh, if cut into small bits. Sometimes two polypes lay hold of the same worm, and each begins

Polypus.

Polypus. begins to swallow its own end till their mouths meet and the worm breaks. But should this happen not to be the case, the one polype will sometimes devour the other along with its portion. It appears, however, that the stomach of one polype is not fitted for dissolving the substance of another; for the one which is swallowed always gets clear again after being imprisoned for an hour or two.

The manner in which the polypes generate is most perceptible in the *grisea* and *fusca*, as being considerably larger than the *viridis*. If we examine one of them in summer, when the animals are most active, and prepared for propagation, some small tubercles will be found proceeding from its sides, which constantly increase in bulk, until at last in two or three days they assume the figure of small polypes. When they first begin to shoot, the excrescence becomes pointed, assuming a conical figure, and deeper colour than the rest of the body. In a short time it becomes truncated, and then cylindrical, after which the arms begin to shoot from the anterior end. The tail adheres to the body of the parent animal, but gradually grows smaller, until at last it adheres only by a point, and is then ready to be separated. When this is the case, both the mother and young ones fix themselves to the sides of the glass, and are separated from each other by a sudden jerk. The time requisite for the formation of the young ones is very different, according to the warmth of the weather and the nature of the food eaten by the mother. Sometimes they are fully formed, and ready to drop off, in 24 hours; in other cases, when the weather is cold, 15 days have been requisite for bringing them to perfection.

It is remarkable, that there is a reciprocal communication of food betwixt the young and old before they be separated. The young ones, as soon as they are furnished with arms, catch prey for themselves, and communicate the digested food to the old ones, who on the other hand do the same to the young ones. This was fully verified by the following experiment: One of the large polypes of the *fusca* kind being placed on a slip of paper in a little water, the middle of the body of a young one growing out from it was cut open; when the superior part of that end which remained fixed to the parent was found to be open also. By cutting over the parent polype on each side of the shoot, a short cylinder was obtained, open at both ends; which being viewed through a microscope, the light was observed to come through the young one into the stomach of the old one. On cutting open the cylindrical portion lengthwise, not only the hole of communication was observed, but one might see through the end of the young one also. On changing the situation of the two pieces, the light was seen through the hole of communication. This may be seen between the parent polype and its young ones after feeding them; for, after the parents have eaten, the bodies of the young ones swell as if they themselves had been eating.

The polypes produce young ones indiscriminately from all parts of their bodies, and five or six young ones have frequently been produced at once; nay, Mr Trembley has observed nine or ten produced at the same time.

Nothing like copulation among these creatures was ever observed by Mr Trembley, though for two years he had thousands of them under his inspection. To be

more certain on this subject, he took two young ones the moment they came from their parent, and placed them in separate glasses. Both of them multiplied, not only themselves, but also their offspring, which were separated and watched in the same manner to the seventh generation; they have even the same power of generation while adhering to their parent. In this state the parent, with its children and grandchildren, exhibits a singular appearance, looking like a shrub thick set with branches. Thus several generations sometimes are attached to one another, and all of them to one parent. Mr Adams gives a figure of one polype with *nineteen* young ones hanging at it; the whole group being about an inch broad, and an inch and an half in length: the old polype eat about twelve monoculi per day, and the young ones about 20 among them.

When a polype is cut transversely or longitudinally into two or three parts, each part in a short time becomes a perfect animal; and so great is this prolific power, that a new animal will be produced even from a small portion of the skin of the old one. If the young ones be mutilated while they grow upon the parent, the parts so cut off will be reproduced, and the same property belongs to the parent. A truncated portion will send forth young ones before it has acquired a new head and tail of its own, and sometimes the head of the young one supplies the place of that which should have grown out of the old one. If we slit a polype longitudinally through the head to the middle of the body, we shall have one formed with two heads; and by slitting these again in the same manner we may form one with as many heads as we please.

A still more surprising property of these animals is, that they may be grafted together. If the truncated portions of a polype be placed end to end, and gently pushed together, they will unite into a single one. The two portions are first joined together by a slender neck, which gradually fills up and disappears, the food passing from the one part into the other; and thus we may form polypes not only from portions of the same, but of different animals; we may fix the head of one to the body of another, and the compound animal will grow, eat, and multiply, as if it had never been divided. By pushing the body of one into the mouth of another, so far that their heads may be brought into contact, and kept there for some time, they will at last unite into one animal, only having double the number of arms which it would otherwise have had. The *hydra fusca* may be turned inside out like a glove, at the same time that it continues to live and act as before. The lining of the stomach now forms the outer skin, and the former epidermis constitutes the lining of the stomach. If previous to this operation the polype have young ones attached to it, such as are but newly beginning to vegetate turn themselves inside out, while the larger ones continue to increase in size till they reach beyond the mouth of the parent, and are then separated in the usual manner from the body. When thus turned the polype combines itself in many different ways. The fore part frequently closes and becomes a supernumerary tail. The animal, which was at first straight, now bends itself, so that the two tails resemble the legs of a pair of compasses, which it can open and shut. The old mouth is placed as it were at the joint of the compasses, but loses its power of action; to supply which, a new one is formed

Polypus. formed in its neighbourhood; and in a little time there is a new species of hydra formed with several mouths.

The sides of a polype, which has been cut through in a longitudinal direction, begin to roll themselves up, commonly from one of the extremities, with the outside of the skin inwards; but in a little time they unroll themselves, and the two cut edges join together, sometimes beginning at one extremity, and sometimes approaching throughout their whole length. As soon as the edges join, they unite so closely that no scar can be perceived. If a polype be partly turned back, the open part closes, and new mouths are formed in different places. Every portion of a polype is capable of devouring insects almost as soon as it is cut off: and the voracity of the whole genus is astonishing; for Mr Adams observes, that most of the insects on which they feed bear the same proportion to the mouth of a polype that an apple of the size of a man's head bears to his mouth.

The *hydra pallens* is very rarely met with, and is described only by M. Roefel. It is of a pale yellow colour, growing gradually smaller from the bottom; the tail is round or knobbed; the arms are about the length of the body, of a white colour, generally seven in number, and are apparently composed of a chain of globules. The young are brought forth from all parts of its body.

The *hydratula* is mentioned by many medical writers. Dr Tyson, in dissecting an antelope, found several hydrides or films, about the size of a pigeon's egg, filled with water, and of an oval form, fastened to the omentum; and some in the pelvis between the bladder of urine and rectum. He suspected them to be animals for the following reasons: 1. Because they were included in a membrane like a matrix, so loosely, that by opening it with the finger or a knife, the internal bladder, containing the serum or lymph, seemed nowhere to have any connection with it, but would very readily drop out, still retaining its liquor without spilling any. 2. This internal bladder had a neck or white body, more opaque than the rest, and protuberant from it, with an orifice at its extremity; by which, as with a mouth, it exhausted the serum from the external membrane, and so supplied its bladder or stomach. 3. On bringing this neck near the candle, it moved and shortened itself. It is found in the abdomen of sheep, swine, mice, &c. lying between the peritoneum and the intestines.

The *stentorea*, or funnel-like polype, is of three colours, green, blue, and white; but the last is the most common. They do not form clusters, but adhere singly by the tail to whatever comes in their way: the anterior end is wider than the posterior; and, being round, gives the animal somewhat of a funnel form, though the circle is interrupted by a kind of slit or gap. The edge of this gap is surrounded with a great number of little finbrillæ, which by their motions excite a current of water, that forces into the mouth of the animal the small bodies that come within its reach. Mr Trembley says, that he has often seen a great number of animalcules fall into the mouths of these creatures; some of which were let out again at an opening which he could not describe. They can fashion their mouths into several different forms; and they multiply by dividing neither transversely nor longitudinally, but diagonally.

The *socialis* is described by Muller under the title of *Polypus vorticella*. They are found in clusters; and when viewed by a microscope, appear like a circle surrounded with crowns or ciliated heads, tied by small thin tails to a common centre, from whence they advance towards the circumference, and then turn like a wheel, occasioning a vortex which brings along with it the food proper for them.

The *angustica*, or clustering polypes, form a group resembling a cluster, or rather an open flower, supported by a stem, which is fixed by its lower extremity to some of the aquatic plants or extraneous bodies that are found in the water; the upper extremity is formed into eight or nine lateral branches, perfectly similar to each other, which have also subordinate branches, whose collective form much resembles that of a leaf. Every one of these assemblages is composed of one principal branch or nerve, which makes the main stem of the cluster an angle somewhat larger than a right one: the smaller lateral branches proceed from both sides of this nerve, and these are shorter the nearer their origin is to the principal branch. There is a polype at the extremity, and others on both sides of the lateral twigs, but at different distances from their extremities. They are all exceedingly small, and bell-shaped, with a quick motion about the mouth, though it is impossible to discern the cause of it. See ANIMALCULE, n° 24, 26, PULEX, and VORTICELLA.

The several strange properties recorded of this animal, though very surprising, are, however, none of them peculiar to it alone. The Surinam toad is well known to produce its young, not in the ordinary way, but in cells upon its back. Mr Sherwood has very lately discovered the small eels in four paste to be without exception full of living young ones. And as to the most amazing of all its properties, the reproduction of its parts, we know the crab and lobster, if a leg be broken off, always produce a new one: and Monf. Bonet, Monf. Lyonet, Monf. de Reaumur, and Mr Folkes, have all found, by experiment, that several earth and water worms have the same property, some of them even when cut into thirty pieces. The urtica marina, or sea-nettle, has been also found to have the same; and the sea star-fish, of which the polype is truly a species, though it had long escaped the searches of the naturalists, was always well known by the fishermen to have it also.

Marine Polypus, is different in form from the freshwater polype already described; but is nourished, increases, and may be propagated, after the same manner; Mr Ellis having often found, in his inquiries, that small pieces cut off from the living parent, in order to view the several parts more accurately, soon gave indications that they contained not only the principles of life, but likewise the faculty of increasing and multiplying into a numerous issue. It has been lately discovered and sufficiently proved by Peyssonel, Ellis, Jussieu, Reaumur, Donati, &c. that many of those substances which had formerly been considered by naturalists as marine vegetables or sea-plants, are in reality animal-productions; and that they are formed by polypes of different shapes and sizes, for their habitation, defence, and propagation. To this class may be referred the corals, corallines, keratophyta, eschara, sponges, and alcyonium: nor is it improbable, that the more compact bodies, known by the

Polypus, the common appellations of *star-stones*, *brain-stones*, *pe-trified fungi*, and the like, brought from various parts of the East and West Indies, are of the same origin. To this purpose Mr Ellis observes, that the ocean, in all the warmer latitudes near the shore, and wherever it is possible to observe, abounds so much with animal life, that no inanimate body can long remain unoccupied by some species. In those regions, ships-bottoms are soon covered with the habitations of thousands of animals: rocks, stones, and every thing lifeless, are covered with them instantly; and even the branches of living vegetables that hang into the water are immediately loaded with the spawn of different animals, shell-fish of various kinds: and shell-fish themselves, when they become impotent and old, are the basis of new colonies of animals, from whose attacks they can no longer defend them-

selves. For a farther account of this system, see **CORAL** and **CORALLINES**.

POLYPUS of the Heart. See **MEDICINE**, n° 97, 98, 274, and 290.

POLYSARCIA, or **CORPULENCY**. See **MEDICINE**, n° 335.

POLYSCHIDES, or **SEA HUNGER**. See **FUCUS**.

POLYSPERMOUS (from *πολυ* and *σπέρμα* *seed*), in botany, is applied to such plants as have more than four seeds succeeding each flower, without any certain order or number.

POLYSYLLABLE, in grammar, a word consisting of more than three syllables; for when a word consists of one, two, or three syllables, it is called a *monosyllable*, a *disyllable*, and a *trisyllable*.

POLYSYNDETON. See **ORATORY**, n° 67.

P O L Y T H E I S M,

Definition. **T**HE doctrine of a plurality of gods or invisible powers superior to man.

* *Sketches of the Hist. of Man.* "That there exist beings, one or many, powerful above the human race, is a proposition (says Lord Kames*) universally admitted as true in all ages and among all nations. I boldly call it *universal*, notwithstanding what is reported of some gross savages; for reports that contradict what is acknowledged to be general among men, require more able vouchers than a few illiterate voyagers. Among many savage tribes, there are no words but for objects of external sense: is it surprising that such people are incapable of expressing their religious perceptions, or any perception of internal sense? The conviction that men have of superior powers, in every country where there are words to express it, is so well vouched, that in fair reasoning it ought to be taken for granted among the few tribes where language is deficient."

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Source of religious principles traced

These are judicious observations, of which every man will admit the force who has not some favourite system to build upon the unstable foundation which his Lordship overturns. Taking it for granted, then, that our conviction of superior powers has long been universal, the important question is, From what cause it proceeds? The same ingenious author shows, with great strength of reasoning, that the operations of nature and the government of this world, which to us loudly proclaim the existence of a Deity, are not sufficient to account for the universal belief of superior beings among savage tribes. He is therefore of opinion, that this universality of conviction can spring only from the image of Deity stamped upon the mind of every human being, the ignorant equally with the learned. "Nothing less (he says) is sufficient: and the original perception which we have of Deity must proceed (he thinks) from an internal sense, which may be termed the *sense of Deity*."

We have elsewhere expressed our opinion of that philosophy which accounts for every phenomenon in human nature, by attributing it to a particular instinct (see **INSTINCT**); but to this instinct or *sense of Deity*, considered as complete evidence, many objections, more than usually powerful, force themselves upon us. All nations, except the Jews, were once polytheists and idolaters. If therefore his Lordship's hypothesis be ad-

mitted, either the doctrine of polytheism must be true theology, or this instinct or sense is of such a nature as to have at different periods of the world misled all mankind. All savage tribes are at present polytheists and idolaters; but among savages every instinct appears in greater purity and vigour than among people polished by arts and sciences; and instinct never mistakes its object. The instinct or primary impression of nature, which gives rise to self-love, affection between the sexes, love of progeny, &c. has in all nations, and in every period of time, a precise and determinate object which it inflexibly pursues. How then comes it to pass, that this particular instinct, which if real is surely of as much importance as any other, should have uniformly led those who had no other guide to pursue improper objects, to fall into the grossest errors and the most pernicious practices? To no purpose are we told, that the sense of Deity, like the moral sense, makes no capital figure among savages. There is reason to believe that the feeling or perception, which is called the *moral sense*, is not wholly instinctive; but whether it be or not, a single instance cannot be produced in which it multiplies its objects, or makes even a savage express gratitude to a thousand persons for benefits which his prince alone had power to confer.

For these, and other reasons which might easily be assigned, we cannot help thinking, that the first religious principles must have been derived from a source different as well from internal sense as from the deductions of reason; from a source which the majority of mankind had early forgotten; and which, when it was banished from their minds, left nothing behind it to prevent the very first principle of religion from being perverted by various accidents or causes, or, in some extraordinary concurrence of circumstances, from being perhaps entirely obliterated. This source of religion every consistent Theist must believe to be revelation. Reason, To reveal- it is acknowledged, and we shall afterwards show (see **RELIGION**), could not have introduced savages to the knowledge of God; and we have just seen, that a *sense* of Deity is an hypothesis clogged with insuperable difficulties. Yet it is undeniable, that all mankind have believed in superior invisible powers: and if reason and instinct be set aside, there remains no other origin of this

^{Theism.} this universal belief than primeval revelation, corrupted, indeed, as it passed by oral tradition from father to son, in the course of many generations. It is no slight support to this doctrine, that if there really be a Deity*, it is highly presumable that he would reveal himself to the first men—creatures whom he had formed with faculties to adore and to worship him. To other animals, the knowledge of a Deity is of no importance; to man, it is of the first importance. Were we totally ignorant of a Deity, this world would appear to us a mere chaos. Under the government of a wise and benevolent Deity, chance is excluded; and every event appears to be the result of established laws. Good men submit to whatever happens without repining, knowing that every event is ordered by Divine Providence: they submit with entire resignation; and such resignation is a sovereign balsam for every misfortune or evil in life.

^{Which} ^{taught} ^{pure} ^{theism.} Admitting, then, that the knowledge of Deity was originally derived from revelation, and that the first men professed pure theism, it shall be our business in the present article to trace the rise and progress of *polytheism* and *idolatry*; and to ascertain, if we can, the real opinions of the Pagan world concerning that multitude of gods with which they filled heaven, earth, and hell. In this inquiry, though we shall have occasion to appeal to the writings of Moses, we shall attribute to them no other authority than what is due to records of the earliest ages, more ancient and authentic than any others which are now extant.

Whether we believe, with the author of the book of Genesis, that all men have descended from the same progenitors; or adopt the hypothesis of modern theorists, that there have been successive creations of men, and that the *European* derives his origin from one pair, the *Asiatic* from another, the woolly-headed *African* from a third, and the copper-coloured *American* from a fourth—polytheism and idolatry will be seen to have arisen from the same causes, and to have advanced nearly in the same order from one degree of impiety to another. On either supposition, it must be taken for granted, that the original progenitors were instructed by their Creator in the truths of genuine theism: and there is no room to doubt, but that those truths, simple and sublime as they are, would be conveyed pure from father to son as long as the race lived in one family, and were not spread over a large extent of country. If any credit be due to the records of antiquity, the primeval inhabitants of this globe lived to so great an age, that they must have increased to a very large number long before the death of the common parent, who would of course be the bond of union to the whole society, and whose dictates, especially in what related to the origin of his being and the existence of his Creator, would be listened to with the utmost respect by every individual of his numerous progeny.

Many causes, however, would conspire to dissolve this family, after the death of its ancestor, into separate and independent tribes, of which some would be driven by violence, or would voluntarily wander, to a distance from the rest. From this dispersion great changes would take place in the opinions of some of the tribes respecting the object of their religious worship. A single family, or a small tribe banished into a desert wilderness (such as the whole earth must then have been), would

VOL. XV. Part I.

find employment for all their time in providing the means of subsistence, and in defending themselves from beasts of prey. In such circumstances they would have little leisure for meditation, and, being constantly conversant with objects of sense, they would gradually lose the power of meditating upon the spiritual nature of that Being by whom their ancestors had taught them that all things were created. The first wanderers would no doubt retain in tolerable purity their original notions of Deity; and they would certainly endeavour to impress those notions upon their children: but in circumstances infinitely more favourable to speculation than theirs could have been, the human mind dwells not long upon notions purely intellectual. We are so accustomed to sensible objects, and to the ideas of space, extension, and figure, which they are perpetually impressing upon the imagination, that we find it extremely difficult to conceive any being without assigning to him a form and a place. Hence a learned writer* has supposed, that the earliest generations of men (even those to whom he contends that frequent revelations were vouchsafed) may have been no better than *anthropomorphites* in their conceptions of the Divine Being.

Be this as it may, it is not conceivable but that the members of those first colonies would quickly lose many of the arts and much of the science which perhaps prevailed in the parent state; and that, fatigued with the contemplation of intellectual objects, they would relieve their overstrained faculties, by attributing to the Deity a place of abode, if not a human form. To men totally illiterate, the place fittest for the habitation of the Deity would undoubtedly appear to be the sun, the most beautiful and glorious object of which they could form any idea; an object, too, from which they could not but be sensible that they received the benefits of light and heat, and which experience must soon have taught them to be in a great measure the source of vegetation. The great spirit therefore inhabiting the sun, which they would consider as the power of light and heat, was in all probability the first object of idolatrous adoration.

From looking upon the sun as the habitation of their God, they would soon proceed to consider it as his body. Of pure mind entirely separated from matter, men in their circumstances could not long retain the faintest notion; but conscious each of power in himself, and experiencing the effects of power in the sun, they would naturally conceive that luminary to be animated as their bodies were animated. They would feel his influence when above the horizon; they would see him moving from east to west; they would consider him when set as gone to take his repose: and those exertions and intermissions of power being analogous to what they experienced in themselves, they would look upon the sun as a real animal. Thus would the Divinity appear to their untutored minds to be a compound being like man, partly corporeal and partly spiritual; and as soon as they imbibed such notions, though perhaps not before, they may be pronounced to have been absolute idolaters.

When man had once got into this train, their gods would multiply upon them with wonderful rapidity. Darkness and cold they could not but perceive to be contrary to light and heat; and not having philosophy enough to distinguish between mere privations and positive

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* See Sketches of the Hist. of Man.

* Bishop Laro in his Considerations on the Theory of Religion.

Magianism. tive effects, they would consider darkness and cold as entities equally real with light and heat; and attribute these different and contrary effects to different and contrary powers. Hence the spirit or power of darkness was in all probability the second god in the Pagan calendar; and as they considered the power of light as a benevolent principle, the source of all that is good, they must have looked upon the contrary power of darkness as a malevolent spirit, the source of all that is evil. This we know from authentic history to have been the belief of the Persian magi, a very ancient sect, who called their good god *Yazdan*, and also *Ormuzd*, and the evil god *Ahriman*. Considering light as the symbol, or perhaps as the body, of *Ormuzd*, they always worshipped him before the fire, the source of light, and especially before the sun, the source of the most perfect light; and for the same reason fires were kept continually burning on his altars. That they sometimes addressed prayers to the evil principle, we are informed by Plutarch in his life of Themistocles; but with what particular rites he was worshipped, or where he was supposed to reside, is not so evident. Certain it is, that his worshippers held him in detestation; and when they had occasion to write his name, they always inverted it (*uowwɔɹɔɹ*), to denote the malignity of his nature.

The principles of the magi, though widely distant from pure theism, were much less absurd than those of other idolaters. It does not appear that they ever worshipped their gods by the medium of graven images, or had any other emblems of them than light and darkness. Indeed we are told by Diogenes Laertius and Clemens Alexandrinus, that they condemned all statues and images, allowing fire and water to be the only proper emblems or representatives of their gods. And we learn from Cicero*, that at their instigation Xerxes was said to have burnt all the temples of Greece, because the builders of those edifices impiously presumed to inclose within walls the gods, to whom all things ought to be open and free, and whose proper temple is the whole world. To these authorities we may add that of all the historians, who agree, that when magianism was the religion of the court, the Persian monarchs made war upon images, and upon every emblem of idolatry different from their own.

The Magi, however, were but one sect, and not the largest sect of ancient idolaters. The worship of the sun, as the source of light and heat, soon introduced into the calendar of divinities the other heavenly bodies, the moon, the planets, and the fixed stars. Men could not but experience great benefit from those luminaries in the absence of their chief god; and when they had proceeded so far as to admit two divine principles, a good and an evil, it was natural for minds clouded with such prejudices to consider the moon and the stars as benevolent intelligences, sent to oppose the power of darkness whilst their first and greatest divinity was absent or asleep. It was thus, as they imagined, that he maintained (for all held that he did maintain) a constant superiority over the evil principle. Though to astronomers the moon is known to be an opaque body of very small dimensions when compared with a planet or a fixed star, to the vulgar eye she appears much more magnificent than either. By those early idolaters she was considered as the divinity second in rank and in

power; and whilst the sun was worshipped as the king, she was adored as the queen, of heaven.

The earth, considered as the common mother of all things; the ocean, whose waters are never at rest; the air, the region of storms and tempests, and indeed all the elements—were gradually added to the number of divinities; not that mankind in this early age had so far degenerated from the principles of their ancestors as to worship brute matter. If such worship was ever practised, which to us is hardly conceivable, it was at a later period, when it was confined to the very lowest of the vulgar, in nations otherwise highly civilized. The polytheists, of whom we now treat, conceived every thing in motion to be animated, and animated by an intelligence powerful in proportion to the magnitude of the body moved.

This sect of idolaters, which remains in some parts of the East to this day, was known by the name of *Sabians*, which they pretend to have derived from *Sabius* a son of Seth; and among the books in which their sacred doctrines are contained, they have one which they call the book of *Seth*. We need hardly observe, that these are senseless and extravagant fables. The name *Sabian* is undoubtedly derived from the Hebrew word *Tsaba*, which signifies “a host or army;” and this class of polytheists was so called, because they worshipped “the host of heaven;” the *Tsaba besemim*, against which Moses so pathetically cautions the people of Israel*.

This species of idolatry is thought to have first prevailed in Chaldea, and to have been that from which Abraham separated himself, when, at the command of the true God, he “departed from his country, and from his kindred, and from his father’s house.” But as it nowhere appears that the Chaldeans had fallen into the savage state before they became polytheists and idolaters, and as it is certain that they were not savages at the call of Abraham, their early Sabiism may be thought inconsistent with the account which we have given of the origin of that species of idolatry. If a great and civilized nation was led to worship the host of heaven, why should that worship be supposed to have arisen among savages? Theories, however plausible, cannot be admitted in opposition to facts.

True: but we beg leave to reply, that our account of the origin of polytheism is opposed by no fact; because we have not supposed that the worship of the host of heaven arose among savages *only*. That savages, between whom it is impossible to imagine any intercourse to have had place, have universally worshipped, as their first and supreme divinities, the *sun, moon, and stars*, is a fact evinced by every historian and by every traveller; and we have shown how their rude and uncultivated state naturally leads them to that species of idolatry. But there may have been circumstances peculiar to the Chaldeans, which led them likewise to the worship of the heavenly host, even in a state of high civilization.—We judge of the philosophy of the ancients by that of ourselves, and imagine that the same refined system of metaphysics was cultivated by them as by the followers of *Descartes* and *Locke*. But this is a great mistake; for so gross were the notions of early antiquity, that it may be doubted whether there was a single man uninspired, who had any notion of mind as a being distinct.

* *De Legibus*, lib. ii. § 10.

to Sabian polytheism

* *Deut.* c. iv. 19. Arose in Chaldea.

Sabiiſm.

ſinēt and entirely ſeparated from matter (ſee METAPHYSICS, Part III. c. 4). From ſeveral paſſages in the books of Moſes, we learn, that when in the firſt ages of the world the Supreme Being condeſcended to manifeſt his preſence to men, he generally exhibited ſome ſenſible emblem of his power and glory, and declared his will from the miſt of a preternatural fire. It was thus that he appeared to the Jewiſh lawgiver himſelf, when he ſpoke to him from the miſt of a burning buſh; it was by a pillar of cloud and fire that he led the Iſraelites from Egypt to the Land of Promiſe; and it was in the miſt of ſmoke, and fire, and thunderings, that the law was delivered from Mount Sinai.—That ſuch manifeſtations of the Divine Preſence would be occaſionally made to the deſcendants of Noah who ſettled in Chaldea ſoon after the deluge, muſt appear extremely probable to every one who admits the authority of the Hebrew Scriptures: and he who queſtions that authority, has no right to make the objection to which we now reply; becauſe it is only from the book of Geneſis that we know the Chaldeans to have been a civilized people when they fell into idolatry. All hiſtories agree in repreſenting the inhabitants of Chaldea as at a very early period corrupted by luxury and ſunk in vice. When this happened, we muſt ſuppoſe that the moral Governor of the univerſe would withdraw from them thoſe occaſional manifeſtations of himſelf, and leave them to their own inventions. In ſuch circumſtances, it was not unnatural for a people addiſted to the ſtudy of aſtronomy, who had been taught to believe that the Deity frequently appeared to their anceſtors in a flame of fire, to conſider the ſun as the place of his permanent reſidence, if not as his body. But when either opinion was firmly eſtabliſhed, polytheiſm would be its inevitable conſequence, and the progreſs of Sabiiſm would, in the moſt poliſhed nation, be ſuch as we have traced it among ſavage tribes.

† In Cratyl.
12
Paſſed into
Egypt, &c.

* Lib. i.
cap. 131.

† Lib. iv.
cap. 188

‡ Lib. i

From Chaldea the idolatrous worſhip of the hoſt of heaven ſpread itſelf over all the Eaſt, paſſed into Egypt, and thence into Greece; for Plato affirms †, that “the firſt inhabitants of Greece ſeemed to him to have worſhipped no other gods but the ſun, moon, earth, ſtars, and heavens, as moſt barbarous nations (continues he) ſtill do.” That Sabiiſm, or the worſhip of the hoſt of heaven, was the firſt ſpecies of idolatry, beſides the probability of the thing, and the many alluſions to it in ſacred Scripture, we have the poſitive evidence of the moſt ancient pagan hiſtorians of whoſe writings any part has been tranſmitted to us. Herodotus *, ſpeaking of the religion of the Perſians, ſays, that “they worſhip the ſun, moon, and earth, fire, water, and the winds; and this adoration they have all along paid from the beginning.” He teſtifies the ſame thing of the ſavage Africans, of whom he affirms †, that they all worſhipped the ſun and moon, and no other divinity. Diodorus Siculus, writing of the Egyptians ‡, tells us, that “the firſt men looking up to the world above them, and terrified and ſtruck with admiration at the nature of the univerſe, ſuppoſed the ſun and moon to be the principal and eternal gods.” And Sanchoniathon the

Phœnician, a more ancient writer than either of theſe, informs us, in the fragment of his hiſtory preſerved by Eufebius, that “the two firſt mortals were Æon and Protogonus; and their children were Genus and Genea, who inhabited Phœnicia; and when they were ſcorched with the heat, they lifted up their hands to the ſun, whom they believed to be the Lord of Heaven, and called him Bual-famen, the ſame whom the Greeks call Zeus.”

Hitherto thoſe divinities were worſhipped in perſon, or, as Dr Prideaux expreſſes it, in their ſacella, or ſacred tabernacles; for the votaries of each directed their devotions towards the planet which they ſuppoſed to be animated by the particular intelligence whom they meant to adore. But theſe orbs, by their riſing and ſetting, being as much below the horizon as above it, and their groſsly ignorant worſhippers not ſuppoſing it poſſible that any intelligence, however divine, could exert its influence but in union with ſome body, ſtatues And produced ſtatue-worſhip, or pillars were ſoon thought of as proper emblems of the abſent gods. Sanchoniathon, in the fragment already quoted, informs us, that “Hyſpouranios and his brother Oufous, Phœnician patriarchs, erected two pillars, the one to fire and the other to air or wind, and worſhipped thoſe pillars, pouring out to them libations of the blood of the wild beaſts hunted down in the chace.” As theſe early monuments of idolatry were called βάβυλια, a word evidently derived from the Hebrew Bethel, the probability is, that they were altars of looſe ſtones, ſuch as that which was built by Jacob §, § Geneſis, and from him received the ſame name. As his waſh. ch. xxxv. conſecrated to the true God, theſe were conſecrated to the hoſt of heaven; and the form of conſecration ſeems to have been nothing more than the anointing of the ſtone or pillar with oil (A), in the name of the divinity whom it was intended to repreſent. When this ceremony was performed, the ignorant idolaters, who fancied that their gods could not hear them but when they were viſible, ſuppoſed that the intelligences by which the ſun and planets were animated, took poſſeſſion, in ſome inexplicable manner, of the conſecrated pillars, and were as well pleaſed with the prayers and praises offered up before thoſe pillars, as with the devotions which were addreſſed towards the luminaries themſelves.—Hence Sanchoniathon calls them animated or living ſtones, λίθους ἐμψυχους, from the portion of the Divine Spirit which was believed to reſide in them; and as they were dedicated to the hoſt of heaven, they were generally erected on the tops of mountains; or in countries which, like Egypt, were low and level, they were elevated to a great height by the labour of men.

It has been ſuppoſed, that this practice of raiſing the pillars on high places proceeded from a deſire to make the objects of worſhip conſpicuous and magnificent: but we are ſtrongly inclined to believe, that the erectors of βάβυλια had ſomething farther in view, and that they thought of nothing leſs than to bring the ſacred ſtone or pillar as near as poſſible to the god whom it repreſented. Whatever be in this, we know that the practice itſelf prevailed univerſally through the eaſt; and that there

(A) Hence the proverb of a ſuperſtitious man, πάντα λίθον λιπαρον περιχυνει, he kiſſes or adores every anointed ſtone which Arnobius calls lubricatam lapidem, et ex olivi unguine ſordidatum.—Stillingfleet's Origines Sacre.

Dæmons.

there was nothing which the Jewish legislator more strictly enjoined his people to destroy, than the altars, statues, and pillars, erected for idolatrous worship upon mountains and high places. "Ye shall utterly destroy (says he) all the places wherein the nations which ye shall possess served their gods, upon the *high mountains*; and upon the *hills*, and under every green tree. And ye shall overthrow their *altars*, and break down their *pillars*, and burn their *groves* with fire *."

* Deut. xii.
23.

The mention of *groves* by the Hebrew lawgiver, brings to our recollection another species of idolatry, which was perhaps the second in order, as men deviating from the principles of pure theism were more and more intangled in the labyrinths of error. The Chaldeans, Egyptians, and all the eastern nations who believed in a superintending providence, imagined that the government of this world, the care of particular nations, and even the superintendence of groves, rivers, and mountains, in each nation, was committed by the gods to a class of spirits superior to the soul of man, but inferior to those heavenly intelligences which animated the sun, the moon, and the planets. These spirits were by the Greeks called *δαίμονες*, *dæmons*, and by the Romans *genii*. Timæus the Locrian, who flourished before

† De Anima
Mundi, in-
ter script. a
T. Gale,
editos.

15
Origin of
dæmon-
worship

Plato, speaking of the punishment of wicked men, says†, all these things hath Nemesis decreed to be executed in the second period, by the ministry of vindictive terrestrial dæmons, who are overseers of human affairs; to which dæmons the Supreme God, the ruler over all, hath committed the government and administration of this world, which is made up of *gods*, *men*, and *animals*.

Concerning the origin of these intermediate beings, scholars and philosophers have framed various hypotheses. The belief of their existence may have been derived from five different sources.

1. It seems to have been impossible for the limited capacities of those men, who could not form a notion of a God divested of a body and a place, to conceive how the influence and agency of such a being could every instant extend to every point of the universe. Hence, as we have seen, they placed the heavenly regions under the government of a multitude of heavenly gods, the *sun*, the *moon*, and the *stars*. But as the nearest of those divinities was at an immense distance from the earth, and as the intelligence animating the earth itself had sufficient employment in regulating the general affairs of the whole globe, a notion insinuated itself into the untutored mind, that these superior governors of universal nature found it necessary, or at least expedient, to employ subordinate intelligences or *dæmons* as ministers to execute their behests in the various parts of their widely extended dominions.

2. Such an universal and uninterrupted course of action, as was deemed necessary to administer the affairs of the universe, would be judged altogether inconsistent with that state of *indolence*, which, especially in the east, was held an indispensable ingredient in perfect felicity. It was this notion, absurd as it is, which made Epicurus deny the *providence*, whilst he admitted the *existence*, of gods. And if it had such an effect upon a philosopher who in the most enlightened ages had many followers, we need not surely wonder if it made untutored idolaters imagine that the governor or governors of the

universe had devolved a great part of their trouble on deputies and ministers.

Dæmons.

3. When men came to reflect on the infinite distance between themselves and the gods, they would naturally form a wish, that there might somewhere exist a class of intermediate intelligences, whom they might employ as mediators and intercessors with their far distant divinities. But what men earnestly wish, they very readily believe. Hence the supposed distance of their gods would, among untutored barbarians, prove a fruitful source of intermediate intelligences, more pure and more elevated than human souls.

4. These three opinions may be denominated popular; but that which we are now to state, wherever it may have prevailed, was the offspring of philosophy.—On this earth we perceive a scale of beings rising gradually above each other in perfection, from mere brute matter through the various species of fossils, vegetables, insects, fishes, birds, and beasts, up to man. But the distance between man and God is infinite, and capable of admitting numberless orders of intelligences, all superior to the human soul, and each rising gradually above the other till they reach that point, wherever it may be, at which creation stops. Part of this immense chasm the philosophers perceived to be actually filled by the heavenly bodies; for in *philosophical* polytheism there was one invisible God supreme over all these: but still there was left an immense vacuity between the human species and the moon, which was known to be the lowest of the heavenly host; and this they imagined must certainly be occupied by invisible inhabitants of different orders and dispositions, which they called good and evil *dæmons*.

5. There is yet another source from which the universal belief of good and evil demons may be derived, with perhaps greater probability than from any or all of these. If the Mosaic account of the creation of the world, the peopling of the earth, and the dispersion of mankind, be admitted as true (and a more consistent account has not as yet been given or devised), some knowledge of good and evil *angels* must necessarily have been transmitted from father to son by the channel of oral tradition. This tradition would be corrupted at the same time, and in the same manner, with others of greater importance. When the true God was so far mistaken as to be considered, not as the sole governor of the universe, but only as the self-extant power of light and good, the Devil would be elevated from the rank of a rebellious created spirit to that of the independent power of darkness and evil; the angels of light would be transformed into good demons, and those of darkness into demons that are evil. This account of the origin of dæmonology receives no small support from Plato, who derives one branch of it wholly from tradition. "With respect to those demons (says he†) who inhabit the space between the earth and

† Timæus.

Here- of probability, and produce no evidence to support their assertions. We must, I say, notwithstanding, give them credit, because they profess to give a detail of facts with which they are intimately acquainted, and the laws of our country oblige us to believe them."

Though these dæmons were generally invisible, they were not supposed to be pure disembodied spirits.— Proclus, in his Commentary upon Plato's *Timæus*, tells us, that "every dæmon superior to human souls consisted of an intellectual mind and an ethereal vehicle." Indeed it is very little probable, that those who gave a body and a place to the Supreme God, should have thought that the inferior orders of his ministers were spirits entirely separated from matter. Plato himself divides the class of dæmons into three orders*; and whilst he holds their souls to be particles or emanations from the divine essence, he affirms that the bodies of each order of dæmons are composed of that particular element in which they for the most part reside. "Those of the first and highest order are composed of pure ether; those of the second order consist of grosser air; and dæmons of the third or lowest rank have vehicles extracted from the element of water. Dæmons of the first and second orders are invisible to mankind. The aquatic dæmons, being invested with vehicles of grosser materials, are sometimes visible and sometimes invisible. When they do appear, though faintly observable by the human eye, they strike the beholder with terror and astonishment." Dæmons of this last order were supposed to have passions and affections similar to those of men; and though all nature was full of them, they were believed to have local attachments to mountains, rivers, and groves, where their appearances were most frequent. The reason of these attachments seems to be obvious. Polytheism took its rise in countries scorched by a burning sun; and dæmons by their composition being necessarily subject in some degree to the influence of heat and cold, it was natural to suppose that they, like men, would delight in the shady grove and in the purling stream. Hence the earliest altars of paganism were generally built in the midst of groves, or on the banks of rivers; because it was believed that in such places were assembled multitudes of those intelligences, whose office it was to regulate the affairs of men, and to carry the prayers and oblations of the devout to the far-distant residence of the celestial gods. Hence too are to be derived the mountain and river gods, with the dryads and hamadryads, the satyrs, nymphs, and fawns, which held a place in the creed of ancient paganism, and make so conspicuous a figure in the Greek and Roman poets.

These different orders of intelligences, which, though worshipped as gods or demigods, were yet believed to partake of human passions and appetites, led the way to the deification of departed heroes and other eminent benefactors of the human race. By the philosophers all souls were believed to be emanations from the divinity; but "gratitude† and admiration, the warmest and most active affections of our nature, concurred to enlarge the object of religious worship, and to make man regard the inventors of arts and the founders of society as having in them more than a common ray of the divinity. So that god-like benefits, bespeaking as it were a god-like mind, the deceased parent of a people was easily advanced into the rank of a dæmon. When the religious bias was in so good a train, natural affection would

have its share in promoting this new mode of adoration. Piety to parents would naturally take the lead, as it was supported by gratitude and admiration, the *primum mobile* of the whole system: and in those early ages, the *natural father* of the tribe often happened to be the *political father* of the people, and the founder of the state. Fondness for the offspring would next have its turn; and a disconsolate father, at the head of a people, would contrive to sooth his grief for the untimely death of a favourite child, and to gratify his pride under the want of *succession*, by paying divine honours to its memory." "For a father ‡ afflicted with untimely mourning, when he had made an image of his child soon taken away, now honoured him as a god, who was then a dead man, and delivered to those that were under him ceremonies and sacrifices." That this was the origin and progress of the worship of departed souls, we have the authority of the famous fragment of Sanchoniathon already quoted, where the various motives for this species of idolatry are recounted in express words. "After many generations (says he) came *Chryso*; and he invented many things useful to civil life, for which, after his decease, he was worshipped as a god. Then flourished *Ouranos* and his sister *Ge*, who deified and offered sacrifices to their father *Hyppis*, when he had been torn in pieces by wild beasts. Afterwards *Cronos* consecrated *Muth* his son, and was himself consecrated by his subjects."

In the reign of *Cronos* flourished a personage of great reputation for wisdom, who by the Egyptians was called *Thoth*, by the Phœnicians *Taautos*, and by the Greeks *Hermes*. According to Plutarch, he was a profound politician, and chief counsellor to *Osiris*, then the king, and afterwards the principal divinity, of Egypt: and we are told by *Philo Byblius*, the translator of Sanchoniathon, "that it was this *Thoth* or *Hermes* who first took the matters of religious worship out of the hands of unskilful men, and brought them into due method and order." His object was to make religion serviceable to the interests of the state. With this view he appointed *Osiris* and other departed princes to be joined with the stars and worshipped as gods; and being by *Cronos* made king of Egypt, he was, after his death, worshipped himself as a god by the Egyptians. To this honour, if what is recorded of him be true, he had indeed a better title than most princes; for he is said to have been the inventor of letters, arithmetic, geometry, astronomy, and hieroglyphics, and was therefore one of the greatest benefactors of the human race which any age or country has ever produced.

That the gods of Greece and Rome were derived from Egypt and Phœnicia, is so universally known, that it is needless to multiply quotations in order to prove that the progress of polytheism among the Greeks and Romans was the same with that which we have traced in more ancient nations. The following translation, however, of the account given by Hesiod of the deification of departed heroes, with which we have been favoured by a learned and ingenious friend, is so just, and in our opinion so beautiful, that we cannot deny ourselves the pleasure of giving it to our readers.

"The gods who dwell on high Olympus' hill,
First fram'd a golden race of men, who liv'd
Under old Saturn's calm auspicious sway.
Like gods they liv'd, their hearts devoid of care,
Beyond

* *Epinionis.*

16
In groves,
and on the
banks of
rivers.

17
Deification
of departed
heroes,

† *Warbur-*
ton's Div.
Leg.

‡ *Wisdom of*
Solomon,
xiv. 15.

18
A political
invention,
which in-
troduced.

Beyond the reach of pain and piercing woes ;
Th' infirmities of age nor felt, nor fear'd.
Their nerves with youthful vigour strung, their days
In jocund mirth they pass, remote from ills. —
Now when this godlike race was lodg'd in earth,
By Jove's high will to demigods they rose,
And airy demons, who benign on earth
Converse—the guides and guardians of mankind.
In darkness veil'd, they range earth's utmost bound,
Dispensing wealth to mortals. This reward
From bounteous Jove awaits illustrious deeds ||."

|| *Egypt. xxi*
metaph.
lib. i. vers.
100, &c.
19
National
and tutelar
gods.

The deification of departed heroes and statesmen was that which in all probability introduced the universal belief of *notional* and *tutelar* gods, as well as the practice of worshipping those gods through the medium of *statues* cut into a *human figure*. When the founder of a state or any other public benefactor was elevated to the rank of a god, as he was believed still to retain human passions and affections, it was extremely natural to suppose that he would regard with a favourable eye that nation for which he had done so much upon earth; that he would oppose its enemies, and protect the laws and institutions which he himself had given it. By indulging the same train of sentiment, each city, and even every family of consequence, found *Lares* and *Penates* among their departed ancestors, to whom they paid the warmest adoration, and under whose protection they believed their private affairs to be placed. As those national and household gods were believed to be in their deified state clothed with airy bodies, so those bodies were supposed to retain the form which their grosser bodies had upon earth. The image of a departed friend might perhaps be formed by the hand of sorrowful affection, before the statue or the shrine of a deity was thought of; but when that friend or benefactor became the object of religious adoration, it was natural for his votaries to enliven their devotion by the view of his similitude. Maximus Tyrius tells us §, that "there is no race of men, whether barbarian or Grecian, living on the sea-coast or on the continent, wandering in deserts or living in cities, which hath not consecrated some kind of symbol or other in honour of the gods." This is certainly true; but there is no good evidence that the first symbols of the gods were statues of men and women. Whilst the sun and other heavenly bodies continued to be the sole objects of religious worship, the symbols consecrated to them were pillars of a *conical* or *pyramidal* figure; and if such pillars are ever called *graven* images by Moses and other ancient writers, it was probably on account of the *allegoric figures* and *characters*, or hieroglyphic writing, with which they were inscribed.

Hitherto we have considered the souls of departed heroes as holding the rank only of demons or demigods; but they gradually rose in the scale of divinities, till they dethroned the heavenly bodies, and became themselves the *dii majorum gentium*. This revolution was effected by the combined operation of the prince and the priest; and the first step taken towards it seems to have been the complimenting of their heroes and public benefactors with the name of that being which was most esteemed and worshipped. "Thus a king for his beneficence was called the *sun*, and a queen for her beauty the *moon*. Diodorus relates, that Sol first reigned

in Egypt, called so from the luminary of that name in the heavens. This will help us to understand an odd passage in the fragment of Sanchoniathon, where it is said that *Cronus had seven sons by Rhea, the youngest of whom was a GOD as soon as BORN*. The meaning probably is, that this youngest son was called after some luminary in the heavens to which they paid divine honours; and these honours came in process of time to be transferred to the terrestrial namesake. The same historian had before told us, that the sons of Genos, mortals like their father, were called by the names of the elements—*light, fire, and flame*, of which they had discovered the use."

"As this adulation advanced into an established worship, they turned the compliment the other way, and called the planet or luminary after the hero, the better to accustom the people, even in the act of *Planet-worship*, to this *new* adoration. Diodorus, in the passage already quoted, having told us, that by the first inhabitants of Egypt the sun and moon were supposed to be the principal and eternal gods, adds, that the former was called *OSIRIS*, and the latter *ISIS*. This was indeed the general practice; for we learn from Macrobius, that the Ammonites called the sun *Moloch*; the Syrians *Adad*; the Arabs *Dionysus*; the Assyrians *Belus*; the Phœnicians *Saturn*; the Carthaginians *Hercules*; and the Palmyrians *Elegabalus*. Again, by the Phrygians the moon was called *Cybele*, or the mother of the gods; by the Athenians *Minerva*; by the Cyprians *Venus*; by the Cretans *Diana*; by the Sicilians *Proserpine*; by others *Hecate*, *Bellona*, *Vesta*, *Urania*, *Lucina*, &c. Philo Byblius explains this practice: "It is remarkable (says he) that the ancient idolaters imposed on the *elements*, and on those parts of nature which they esteemed gods, the names of their kings: for the natural gods which they acknowledged were only the sun, moon, planets, elements, and the like; they being now in the humour of having gods of both classes, the *mortal* and the *immortal*."

"As a farther proof that *hero-worship* was thus superinduced upon the *planetary*, it is worthy of observation, that the first statues consecrated to the *greater* hero-gods—those who were supposed to be *supreme*—were not of a human form, but *conical* or *pyramidal*, like those which in the earliest ages of idolatry were dedicated to the sun and planets. Thus the scholiast on the *Vespæ* of Aristophanes tells us, that the statues of Apollo and Bacchus were *conic* pillars or obelisks; and Pausanias, that the statue of Jupiter Meilichius represented a *pyramid*; that of the Argive Juno did the same, as appears from a verse of Phoronis quoted by Clemens Alexandrinus ‡; and indeed the practice was universal as well amongst the early barbarians as amongst the Greeks. But it is well known that the ancients represented the *rays of light* by pillars of a conical or pyramidal form; and therefore it follows, that when they erected such pillars as representatives of their hero-gods, these latter had succeeded to the titles, rights, and honours of the *natural* and *celestial* divinities *."

But though it seems to be certain that *hero-worship* was thus engrafted on the *planetary*, and that some of those heroes in process of time supplanted the planets themselves, this was such a revolution in theology as could not have been suddenly effected by the united influence of the prince and the priest. We doubt not the

Worship.

21
Which in
time it sup-
planted.

§ *Differt.*
38.

20
Hero-wor-
ship en-
grafted on
the *planetary*.

* *Warbur-*
ton's Dio.
leg. book 3.
sect. 6.

‡ *Strom. l. i.*

Hero- the fact that SOL was believed to have reigned in Egypt, and was afterwards worshipped under the name of *Osiris*; but it was surely impossible to persuade any nation, however stupid or prone to idolatry, that a man, whom they remembered discharging the duties of their sovereign and legislator, was the identical sun whom they beheld in the heavens. *Osiris*, if there was in Egypt a king of that name, may have been deified immediately after his death, and honoured with that worship which was paid to good *dæmons*; but he must have been dead for ages before any attempt was made to persuade the nation that he was the *supreme God*. Even then great address would be requisite to make such an attempt successful. The prince or priest who entered upon it would probably begin with declaring from the oracle, that the divine intelligence which animates and governs the sun had descended to earth and animated the person of their renowned legislator; and that, after their laws were framed, and the other purposes served for which the descent was made, the same intelligence had returned to its original residence and employment among the celestials. The possibility of this double transmigration from heaven to earth and from earth to heaven, would without difficulty be admitted in an age when the pre-existence of souls was the universal belief. Having proceeded thus far in the apotheosis of dead men, the next step taken in order to render it in some degree probable that the early founders of states, and inventors of arts, were divine intelligences clothed with human bodies, was to attribute to one such benefactor of mankind the actions of many of the same name. *Vossius*, who employed vast erudition and much time on the subject, has proved, that before the æra of the Trojan wars most kings who were very powerful, or highly renowned for their skill in legislation, &c. were called *Jove*; and when the actions of all these were attributed to one *Jove of Crete*, it would be easy for the crafty priest, supported by all the power and influence of the state, to persuade an ignorant and barbarous people, that he whose wisdom and heroic exploits so far surpassed those of ordinary men must have been the supreme God in human form.

23
Vices of the
pagan gods

This short sketch of the progress of polytheism and idolatry will enable the reader to account for many circumstances recorded of the pagan gods of antiquity, which at first view seem very surprising, and which at last brought the whole system into contempt among the philosophers of Athens and Rome. The circumstances to which we allude are the immoral characters of those divinities, and the abominable rites with which they were worshipped. Jupiter, Apollo, Mars, and the whole rabble of them, are described by the poets as ravishers of women and notorious adulterers. *Hermes* or *Mercury* was a thief, and the god of thieves. *Venus* was a prostitute, and *Bacchus* a drunkard. The malice and revenge of *Juno* were implacable; and so little regard was any of them supposed to pay to the laws of honour and rectitude, that it was a common practice of the Romans, when besieging a town, to evocate the tutelar deity, and to tempt him by a reward to betray his friends and votaries †. In a word, they were, in the language of the poet,

† *T. Livii*,
l. v. c. 21.
et *Macrob.*
Satur.
lib. iii, c. 9.

"Gods partial, changeful, passionate, unjust,
"Whose attributes were rage, revenge, and lust †."

This was the natural consequence of their origin. Flaring once animated human bodies, and being supposed still to retain human passions and appetites, they were believed, in their state of deification, to feel the same sensual desires which they had felt upon earth, and to pursue the same means for their gratification. As the men could not well attempt to surpass the gods in purity and virtue, they were easily persuaded by artful and profligate priests, that the most acceptable worship which could be rendered to any particular deity was to imitate the example of that deity, and to indulge in the practices over which he presided. Hence the worship of *Bacchus* was performed during the night by men and women mixing in the dark after intemperate eating and drinking †. Hence too it was the practice in Cyprus and some other countries to sacrifice to *Venus** the virginity of young women some days before their marriage, in order, as it was pretended, to secure their chastity ever afterwards; and, if *Herodotus* may be credited, every woman among the Babylonians was obliged once in her life to prostitute herself in the temple of the goddess *Mylite* (*Venus*), that she might thenceforward be proof against all temptation.

25
Progress of
polytheism,
as far as we
have traced
it, has been
regular; and
after the enormous
error of idolatry
was admitted,
every subsequent
step appears to
be natural. It
would be no
difficult task to
prove that it has
likewise been
universal. Sir
William Jones,
the learned president
of the Asiatic
Society, has discovered
such a striking
resemblance between
the gods of ancient
Greece and those
of the pagans of
Hindustan †, as
puts it beyond a
doubt that those
divinities had the
same origin. The
GANESA of the
Hindoos he has
clearly proved to
be the JANUS
of the Greeks and
Romans. As the
latter was represented
with two and
sometimes with
four faces, as
emblems of
prudence and
circumspection,
the former is
painted with an
elephant's head,
the well-known
symbol among
the Indians of
sagacious discernment.
The *SATYAVRATA*
of Greece and
Rome appears to
have been the
same personage
with the *MENU*
or *SATYAVRATA*
of Hindustan,
whose patronymic
name is *VAIVASWATA*,
or *child of the sun*;
which sufficiently
marks his origin.
Among the
Romans there
were many
Jupiters, of
whom one
appears from
Ennius to have
been nothing
more than the
firmament
personified.

Aspice hoc sublime cœdens, quem invocant omnes
JOVEM.

But this Jupiter had the same attributes with the Indian god of the visible heavens called *INDRA* or the king, and *DIVESPETIR* or the lord of the sky, whose consort is *Sachi*, and whose weapon is *vajra* or the thunderbolt. *INDRA* is the regent of winds and showers; and though the east is peculiarly under his care, yet his Olympus is the north-pole, allegorically represented as a mountain of gold and gems. With all his power he is considered as a subordinate deity, and far inferior to the Indian triad *BRAHMA*, *VISHNOU*, and *MAHADEVA* or *SIVA**, who are three forms of one and the same godhead. The president having traced the resemblance between the idolatry of Rome and India through many other gods, observes, that "we must not be surprised at finding, on a close examination, that the characters of all the pagan deities melt into each other, and at last into

* *Plato*.
CCCCXI.

Hero-
Worship.

into one or two; for it seems a well-founded opinion, that the whole crowd of gods and goddesses in ancient Rome, and likewise in Hindostan, mean only the powers of nature, and principally those of the sun, expressed in a variety of ways, and by a multitude of fanciful names."

Nor is it only in Greece, Rome, Egypt, and India, that the progress of idolatry has been from planetary to hero-worship. From every account which modern travellers have given us of the religion of savage nations, it appears that those nations adore, as their first and greatest gods, the sun, moon, and stars; and that such of them as have any other divinities have proceeded in the same road with the celebrated nations of antiquity, from the worship of the heavenly bodies to that of celestial demons, and from celestial demons to the deification of dead men. It appears likewise that they universally believe their hero-gods and demigods to retain the passions, appetites, and propensities of men.

27
Scandi-
avian and
Saxon ido-
latry.

* Plate
CXXI.

That the Scandinavians and our Saxon ancestors had the same notions of the gods with the other pagans whose opinions we have stated, is evident from their calling the days of the week by the names of their divinities, and from the forms of the statues by which those divinities were represented*. 1. The idol of the sun, from which *Sunday* is derived, among the Latins *dies Solis*, was placed in a temple, and adored and sacrificed to; for they believed that the sun did co-operate with this idol. He was represented like a man half naked, with his face like the sun, holding a burning wheel with both hands on his breast, signifying his course round the world; and by its fiery gleams, the light and heat with which he warms and nourisheth all things.— 2. The idol of the moon, from which cometh our *Monday*, *dies Luna*, anciently *Moonday*, appears strangely singular, being habited in a short coat like a man. Her holding a moon expresses what she is; but the reason of her short coat and long-eared cap is lost in oblivion.— 3. *Tuisco*, the most ancient and peculiar god of the Germans, represented in his garment of a skin according to their ancient manner of clothing, was next to the sun and moon, the idol of highest rank in the calendar of northern paganism. To him the third day in the week was dedicated; and hence is derived the name *Tuesday*, anciently *Tuisday*, called in Latin *dies Martis*, though it must be confessed that Mars does not so much resemble this divinity as he does Odir or Woden.

4. *Woden* was a valiant prince among the Saxons. His image was prayed to for victory over their enemies; which, if they obtained, they usually sacrificed the prisoners taken in battle to him. Our *Wednesday* is derived from him, anciently *Wodnesday*. The northern histories make him the father of *Thor*, and *Friga* to be his wife.

5. *Thor* was placed in a large hall, sitting on a bed canopied over, with a crown of gold on his head, and 12 stars over it, holding a sceptre in the right hand. To him was attributed the power over both heaven and

earth; and that as he was pleased or displeased he could send thunder, tempests, plagues, &c. or fair, seasonable weather, and cause fertility. From him our *Thursday* derives its name, anciently *Thorfsday*; among the Romans *dies Jovis*, as this idol may be substituted for Jupiter.

Brute-
Worship.

6. *Friga* represented both sexes, holding a drawn sword in the right hand and a bow in the left; denoting that women as well as men should fight in time of need. She was generally taken for a goddess; and was reputed the giver of peace and plenty, and causer of love and amity. Her day of worship was called by the Saxons *Frigedeag*, now *Friday*, *dies Veneris*; but the habit and weapons of this figure have a resemblance of Diana rather than Venus.

7. *Seater*, or *Crodo*, stood on the prickly back of a perch. He was thin-visaged and long-haired, with a long beard, bare-headed and bare-footed, carrying a pail of water in his right hand wherein are fruit and flowers, and holding up a wheel in his left, and his coat tied with a long girdle. His standing on the sharp fins of this fish signified to the Saxons, that by worshipping him they should pass through all dangers unhurt; by his girdle flying both ways was shown the Saxons freedom; and by the pail with fruit and flowers, was denoted that he would nourish the earth. From him, or from the Roman deity Saturn, comes *Saturday*.

Such were the principal gods of the northern nations: but these people had at the same time inferior deities, who were supposed to have been translated into heaven for their heroic deeds, and whose greatest happiness consisted in drinking *ale* out of the skulls of their enemies in the *hall of Woden*. But the limits prescribed to the present article do not permit us to pursue this subject; nor is it necessary that we should pursue it. The attentive reader of the article MYTHOLOGY, of the histories given in this work of the various divinities of paganism, and of the different nations by whom those divinities were worshipped, will perceive that the progress of polytheism and idolatry has been uniform over the whole earth.

There is, however, one species of idolatry more wonderful than any thing that has yet been mentioned, of which our readers will certainly expect some account.

28
It is the worship of *brutes*, *reptiles*, and *vegetables*, among the Egyptians. To the Greeks and Romans, as well as to us, that superstition appeared so monstrous, that to enumerate every hypothesis, ancient and modern, by which philosophers have endeavoured to account for it, would swell this article beyond all proportion. Brute-worship prevailed at so early a period in Egypt, that the philosophers of antiquity, whose writings have descended to us, had little or no advantage over the moderns in pursuing their researches into its origin; and among the modern hypotheses, those of *Misbeim* and *Warburton* appear to us by much the most probable of any that we have seen (B). The former of these learned writers attributes it wholly to the policy of the prince and

Brute-
worship of
the Egyp-
tians.

(B) There is, however, another hypothesis worthy of some attention, if it were only for the learning and ingenuity of its author. The celebrated Cudworth infers, from the writings of Plato and other Platonists of the Alexandrian school, that the ancient Egyptians held the Platonic doctrine of ideas existing from eternity, and constituting, in one of the persons of the godhead, the intelligible and archetypal world. (See PLATONISM.) Philo,

Brute-
Worship.

and the craft of the priest. The latter contends, with much earnestness and ingenuity, that it resulted from the use of hieroglyphic writing. We are strongly inclined to believe that both these causes contributed to the production of so portentous an effect; and that the use of hieroglyphics as sacred symbols, after they were laid aside in civil life, completed that wonderful superstition which the craft of the priest and the policy of the prince had undoubtedly begun.

* Lib. 2.
c. 65.
29
Introduced
with a po-
litical view.

† Cudworth,
Intellect
Syst. cap. 4.
n^o 158.

* See Ich-
neumon and
Ibis.

We learn from Herodotus*, that in his time the number of useful animals in Egypt was so small as hardly to be sufficient for tillage and the other purposes of civil life; whilst serpents and other noxious animals, such as the crocodile, wolf, bear, and hippopotamus, abounded in that country. From this fact Mosheim very naturally concludes†, that the founders of society and government in Egypt would by every art endeavour to increase the number of useful animals as the number of inhabitants increased; and that with this view they would make it criminal to kill or even to hurt sheep, cows, oxen, or goats, &c. whilst they would wage perpetual war upon the noxious animals and beasts of prey. Such animals as were assisting to them in the carrying on of this warfare would be justly considered as in a high degree useful to society. Hence the most grievous punishments were decreed against the killing, or so much as the wounding, of the *ichneumon* and *ibis*; because the former was looked upon as the instinctive enemy of the crocodile, and the latter of every species of serpents*. The learned writer, however, observes, that in Egypt as in other countries, people would be tempted to sacrifice the good of the public to the gratification of their own appetites, and sometimes even to the indulgence of a momentary caprice. Hence he thinks it was found necessary to strengthen the authority of the laws enacted for the preservation of useful animals by the sanctions of religion: and he says, that with this view the priests declared that certain animals were under the immediate protection of certain gods; that some of those animals had a divine virtue residing in them; and that they could not be killed without the most sacrilegious wickedness, incurring the highest indignation of the gods. When once the idolatrous Egyptians were persuaded that certain animals were sacred to the immortal gods, and had a divine virtue residing in them, they could not avoid viewing those animals with some degree of veneration; and the priests, taking advantage of the superstition of the peo-

ple, appointed for each species of sacred animals appropriated rites and ceremonies, which were quickly followed with building shrines and temples to them, and approaching them with oblations, and sacrifices, and other rites of divine adoration.

To corroborate this hypothesis, he observes, that, besides the animals sacred over all Egypt, each province and each city had its particular animal to which the inhabitants paid their devotions. This arose from the universal practice among idolaters of consecrating to themselves *Lares* and *Penates*; and as the animals which were worshipped over the whole kingdom were considered as sacred to the *Dii majorum gentium*, so the animals whose worship was confined to particular cities or provinces were sacred to the *Lares* of those cities and provinces. Hence there was in Upper Egypt a city called *Lycopolis*, because its inhabitants worshipped the wolf, whilst the inhabitants of *Thebes* or *Heliopolis* paid their devotions to the eagle, which was probably looked upon as sacred to the sun. Our author, however, holds it as a fact which will admit of no dispute, that there was not one noxious animal or beast of prey worshipped by the Egyptians till after the conquest of their country by the Persians. That the earliest gods of Egypt were all benevolent beings, he appeals to the testimony of Diodorus Siculus; but he quotes Herodotus and Plutarch, as agreeing that the latter Egyptians worshipped an evil principle under the name of *Typhon*. This *Typhon* was the inveterate enemy of *Osiris*, just as *Abraman* was of *Ormuzd*; and therefore he thinks it in the highest degree probable that the Egyptians derived their belief of two self-existent principles, a good and an evil, from their Persian conquerors, among whom that opinion prevailed from the earliest ages.

From whatever source their belief was derived, *Typhon* was certainly worshipped in Egypt, not with a view of obtaining from him any good, for there was nothing good in his nature, but in hopes of keeping him quiet, and averting much evil. As certain animals had long been sacred to all the benevolent deities, it was natural for a people so besotted with superstition as the Egyptians to consecrate emblems of the same kind to their god *Typhon*. Hence arose the worship of *serpents*, *crocodiles*, *bears*, and other noxious animals and beasts of prey. It may indeed seem at first sight very inconsistent to deify such animals, after they had been in the practice for ages of worshipping others for being

X x

their

Philo, he observes, did not himself consider those ideas as so many distinct *substances* and *animals*, much less as *gods*; but he mentions others who deified the whole of this intelligible system as well as its several parts. Hence, when they paid their devotions to the *sensible sun*, they pretended to worship only the divine *idea* or *archetype* of that luminary: and hence, thinks our learned author, the ancient Egyptians, by falling down to bulls, and cows, and crocodiles, meant at first to worship only the divine and eternal *ideas* of those animals. He allows, indeed, that as few could entertain any thoughts at all of those eternal ideas, there were scarcely any who could persuade themselves that the *intelligible system* had so much reality in it as the *sensible things of nature*; and hence he thinks the devotion which was originally paid to the divine ideas had afterwards no higher object than the brutes and vegetables of which those ideas were the eternal patterns.

This hypothesis is ingenious, but not satisfactory. There is no evidence that the mysterious doctrine of Plato concerning *ideas* had anywhere been thought of for ages after brute-worship was established in Egypt. Of the state of Egyptian theology at that early period, Philo, and the other philosophers of the Alexandrian school, had no better means of forming a judgment than we have; and they laboured under many Grecian prejudices, which must have prevented them from judging with our impartiality.

Brute-
Worship.

their destroyers; but it is to be remembered, that long before the deification of crocodiles, &c. the real origin of brute worship was totally forgotten by the people, if they were ever acquainted with it. The crafty priest who wishes to introduce a gainful superstition, must at first employ some plausible reason to delude the multitude; but after the superstition has been long and firmly established, it is obviously his business to keep its origin out of sight.

Such is Mosheim's account of the origin and progress of that species of idolatry which was peculiar to Egypt; and with respect to the *rise* of brute worship, it appears perfectly satisfactory. But the Egyptians worshipped several species of vegetables; and it surely could be no part of the policy of wise legislators to preserve them from destruction, as vegetables are useful only as they contribute to animal subsistence. We are therefore obliged to call in the aid of Warburton's hypothesis to account for this branch of Egyptian superstition.

* *Div. Leg.*
book 4th,
sect. 4th.
30
Continued
by the
means of
hieroglyphic
writing, and

That learned and ingenious author having proved*, with great clearness and strength of argument, that hieroglyphic writing was prior to the invention of alphabetic characters; and having traced that kind of writing from such rude pictures, as those which were in use among the Mexicans, through all the different species of what he calls *euriologic*, *tropical*, and *symbolic* hieroglyphics (see *HIEROGLYPHICS*)—shows, by many quotations from ancient authors, that the Egyptian priests wrapt up their theology in the symbolic hieroglyphics, after alphabetic characters had banished from the transactions of civil life a mode of communicating information necessarily so obscure. These symbols were the figures of animals and vegetables, denoting, from some imaginary analogy, certain attributes of their divinities; and when the vulgar, forgetting this analogy, ceased to understand them as a species of writing, and were yet taught to consider them as sacred, they could not well view them in any other light than as emblems of the divinities whom they adored. But if rude sculptures upon stone could be emblematical of the divinities, it was surely not unnatural to infer, that the living animals and vegetables which those sculptures represented must be emblems of the same divinities more striking and more sacred. Hence the learned author thinks arose that wonderful superstition peculiar to the Egyptians, which made them worship not only animals and vegetables, but also a thousand chimeras of their own creation; such as figures with human bodies and the heads or feet of brutes, or with brutal bodies and the heads and feet of men.

These two hypotheses combined together appear to us to account sufficiently for the idolatry of Egypt, monstrous as it was. We are persuaded, that with respect to the *origin* of brute-worship, Mosheim is in the right (c); and it was a very easy step for people in so

good training to proceed upon the crutches of hieroglyphics to the worship of plants and those chimeras, which, as they never had a real existence in nature, could not have been thought of as emblems of the divinity, had they not been used in that symbolic writing which Warburton so ably and ingeniously explains.

To this account of the origin of brute-worship we are fully aware that objections will occur. From a learned friend, who perused the article in manuscript, we have been favoured with one which, as it is exceedingly plausible, we shall endeavour to obviate. "Brute-worship was not peculiar to Egypt. The Hindoos, it is well known, have a religious veneration for the cow and the alligator; but there is no evidence that in India the number of useful animals was ever so small as to make the interference of the prince and the priest necessary for their preservation; neither does it appear that the Hindoos adopted from any other people the worship of a self-existent principle of evil." Such is the objection. To which we reply,

That there is every reason to believe that brute-worship was introduced into India by a colony of Egyptians at a very remote period. That between these two nations there was an early intercourse, is universally allowed: and though the learned president of the Asiatic Society has laboured to prove, that the Egyptians derived all that wisdom for which they were famed, as well as the rudiments of their religious system, from the natives of Hindostan, he does not appear to us to have laboured with success. To examine his arguments at length would swell this article beyond its due proportion; and we have noticed some of them elsewhere (see *PHILOLOGY*, n° 33 and 39.) At present we shall only observe, that Sesostris undoubtedly made an inroad into India, and conquered part of the country, whilst we nowhere read of the Hindoos having at any time conquered the kingdom of Egypt. Now, though the victors have sometimes adopted the religion of the vanquished, the contrary has happened so much more frequently, and is in itself a process so much more natural, that this single circumstance affords a strong presumption that the Egyptian monarch would rather impose his gods upon the Hindoos than adopt theirs and carry them with him to Egypt. Brute-worship might likewise be introduced into Hindostan by those vast colonies of Egyptians who took refuge in that country from the tyranny and oppression of the shepherd kings. That such colonies did settle on some occasion or other in India, seems undeniable from monuments still remaining in that country of forms which could hardly have occurred to a native of Asia, though they are very natural as the workmanship of Africans. But we need not reason in this manner. We have seen a manuscript letter from Mr Burt, a learned surgeon in Bengal, and a member of the Asiatic Society, which puts it beyond a doubt that great numbers of Egyptians had at a very early

Brute-
Worship.31
Carried
from E-
gypt into
India.

(c) To prove that it was merely to preserve and increase the breed of useful animals in Egypt, that the prince and the priest *first* taught the people to consider such animals as sacred, he argues thus: "Hæc ita esse, non ex eo tantum liquet, quod paulo ante observavi, nullas bestias universo Ægyptiorum populo sacras fuisse, præter eas, quæ manifestam regionis utilitatem comparant; sed inde quoque apparet, quod longe major ratio habita fuit semellarum inter animalia, quam marium. Boves diis immolare licebat, vaccas nullo modo. Canes feminae contumulabantur, non item mares." *Leges HERODOTI. Hist. lib. ii. cap. 41. & cap. 67.*

Theogony. early period not only settled in Hindostan, but also brought with them writings relating to the history of their country. As the shepherd-kings were enemies to the arts and to literature, it is probable that this settlement took place on their conquest of Egypt. Mr Burt's words are: "Mr Wilford, lieutenant of engineers, has extracted most wonderful discoveries from the Shanferit records; such as the origin and history of the Egyptian pyramids, and even the account of the expence in their building." Upon our hypothesis there is nothing incredible in this account; upon the hypothesis of Sir William Jones, it is not easy to be conceived how the history of *Egyptian* pyramids could have found a place in the *Shanferit* records.

We may admit that the Hindoos have never adopted from the Persians or Egyptians the worship of an independent principle of evil, and yet dispose of the other part of the objection with very little difficulty. It will be seen by and bye, that the bramins believe a kind of triad of hypostases in the divine nature, of which one is viewed as the *destroyer*, and known by several names, such as *Siva* and *Isvara*. When brute-worship was introduced into Hindostan, it was not unnatural to consider the alligator as emblematical of *Isvara*; and hence in all probability it is that the Hindoos believe that a man cannot depart more happily from this world than by falling into the Ganges, and being devoured by one of those sacred animals. Upon the whole, the bruteworship of the Hindoos, instead of militating against our account of that monstrous superstition as it prevailed in Egypt, seems to lend no small support to that account, as there was unquestionably an early intercourse between the two nations, and as colonies of Egyptians settled in India. To him who is not satisfied with our reasoning on this subject, we beg leave to recommend an attentive perusal of Maurice's *Indian Antiquities*, where he will find many facts brought together, which tend to prove that Egypt has a just claim to a higher antiquity than India.

62
Polytheists
acknowledged one
supreme
God,

Having thus traced the rise and progress of polytheism and idolatry as they prevailed in the most celebrated nations of antiquity, we now proceed to inquire into the real opinions of those nations concerning the nature of the gods whom they adored. And here it is evident from the writings of Homer, Hesiod, and the other poets, who were the principal theologians among the Greeks and Romans, that though heaven, earth, hell, and all the elements, were filled with divinities, there was yet one who, whether called *Jove*, *Osiris*, *Ormuzd*, or by any other title, was considered as supreme over all the rest. "Whence each of the gods was generated (says Herodotus*), or whether they have all existed from eternity, and what are their *forms*, is a thing that was not known till very lately; for Hesiod and Homer were, as I suppose, not above four hundred years my seniors; and these were they who introduced

* Lib. 2.
c. 51.

the theogony among the Greeks, and gave the gods their several names." Now Hesiod†, towards the beginning of his theogony, expressly invokes his muse to celebrate in suitable numbers the generation of the immortal gods who had sprung from the earth, the dark night, the starry heavens, and the salt sea. He calls upon her likewise to say, "in what manner the gods, the earth, the rivers, ocean, stars, and firmament, were generated, and what divine intelligences had sprung from them of benevolent dispositions towards mankind." From this invocation, it is evident that the poet did not consider the gods of Greece as self-existent beings: neither could he look upon them as *creatures*; for of creation the ancient Greeks had no conception (see *METAPHYSICS*, n° 264.); but he considered them as emanations coeval with the earth and heavens, from some superior principles; and by the divine intelligences sprung from them, there cannot be a doubt but that he understood benevolent *dæmons*. The first principles of all things, according to the same Hesiod, were *Chaos*, and *Tartarus*, and *Love*; of which only the last being active, must undoubtedly have been conceived by this father of Grecian polytheism to be the greatest and only self-existing god. This we say must undoubtedly have been Hesiod's belief, unless by *Tartarus* we here understand a self-existent principle of evil; and in that case his creed will be the same with that of the ancient Persians, who, as we have seen, believed in the self-existence as well of *Abraham* as of *Ormuzd*.

Hesiod is supposed to have taken his theology from Orpheus; and it is evident that his doctrine concerning the generation of the gods is the same with that taught in certain verses* usually attributed to Orpheus, in which Love and Chaos are thus brought together. "We will first sing (says the poet) a pleasant and delightful song concerning the ancient Chaos, how the heavens, earth, and seas, were formed out of it; as also concerning that all-wise *Love*, the oldest and self-perfect principle, which actively produced all these things, separating one from another." In the original passage, Love is said not only to be *πολυμήνης* of much wisdom or sagacity, and therefore a real intelligent substance; but also to be *πρῶτατος* and *αὐσιότατος* the oldest and self-perfect, and therefore a being of superior order to the other divinities who were generated together with the elements over which they were conceived to preside.

With the theology of Homer our readers of all descriptions are so well acquainted, that we need not swell the article with quotations, to prove that the father of epic poetry held *Jove* to be the father of gods and men. But the doctrine of the poets was the creed of the vulgar Greeks and Romans; and therefore we may conclude, that those nations, though they worshipped gods and lords innumerable, admitted but one, or at the most two (D), self-existent principles; the one good and the other evil. It does not indeed appear, that in the

X x 2

system

(D) Plutarch is commonly supposed, and we think justly supposed, to have been a believer in two self-existent principles, a good and an evil. His own opinion, whatever it was, he declares (*de Iside et Osiride*) to have been most ancient and universal, and derived from theologers and lawgivers by poets and philosophers. "Though the first author of it be unknown, yet (says he) it hath been so firmly believed everywhere, that traces of it are to be found in the sacrifices and mysteries both of the barbarians and the Greeks. There is a confused mixture of good and evil in every thing, and nothing is produced by nature pure. Wherefore

Theogony. system of vulgar paganism the subordinate gods were accountable to their chief for any part of their conduct, except when they transgressed the limits of the provinces assigned them. Venus might conduct the amours of heaven and earth in whatever manner she pleased; Minerva might communicate or withhold wisdom from any individual with or without reason; and we find, that in Homer's battles the gods were permitted to separate into parties, and to support the Greeks or Trojans according as they favoured the one or the other nation. Jove indeed sometimes called them to order; but his interference was thought partial, and an instance of tyrannical force rather than of just authority. The vulgar Greeks, therefore, although they admitted but one, or at most two, self-existent principles, did not consider the inferior divinities as mediators between them and the supreme, but as gods to whom their worship was on certain occasions to be ultimately directed.

35
Creed of
the philo-
sophers and

The creed of the philosophers seems to have been different. Such of them as were theists, and believed in the administration of Providence, admitted of but one God, to whom worship was ultimately due; and they adored the subordinate divinities as his children and ministers, by whom the course of Providence was carried on. With respect to the origin of those divinities, ** Timæus*, Plato is very explicit; where he tells us*, that "when all the gods, both those who move visibly round the heavens, and those who appear to us as often as they please, were generated, that God, who made the whole universe, spoke to them after this manner: Ye gods of gods, of whom I myself am father, attend." Cicero teaches the very same doctrine with Plato concerning the gods†; and Maximus Tyrius, who seems to have understood the genius of polytheism as thoroughly as any man, gives us the following clear account of that system as received by the philosophers.

† *Tuſc.*
Quæſt. lib. i.
c. 29. et de
Nat. Deo-
rum, paſſim.
‡ *Differt. i.*

"I will now more plainly declare my sense‡ by this similitude: Imagine a great and powerful kingdom or principality, in which all agree freely and with one consent to direct their actions according to the will and command of one supreme king, the oldest and the best; and then suppose the bounds and limits of this empire not to be the river Halys, nor the Hellespont, nor the

Meotian lake, nor the shores of the ocean; but heaven **Theogony.** above, and the earth beneath. Here then let that great king sit immovable, prescribing to all his subjects laws, in the observance of which consist their safety and happiness: the partakers of his empire being many, both visible and invisible gods; some of which that are nearest, and immediately attending on him, are in the highest regal dignity, feasting as it were at the same table; others again are their ministers and attendants; and a third sort are inferior to them both: and thus you see how the order and chain of this government descends down by steps and degrees from the supreme God to the earth and men." In this passage we have a plain acknowledgment of one supreme God, the sovereign of the universe, and of three inferior orders of gods, who were his ministers in the government of the world; and it is worthy of observation, that the same writer calls these intelligences *θεοὺς θεῶν παῖδας καὶ φίλους*, *gods, the sons and friends of God*. He likewise affirms, that all ranks of men, and all nations on earth, whether barbarous or civilized, held the same opinions respecting one supreme Numen and the generation of the other gods.

"If there were a meeting (says he*) called of all * *Ibid.* these several professions, a painter, a statuary, a poet, and a philosopher, and all of them were required to declare their sense concerning *the God*; do you think that the painter would say one thing, the statuary another, the poet a third, and the philosopher a fourth? No; nor the Seythian neither, nor the Greek, nor the Hyperborean. In other things we find men speaking very discordantly, all men as it were differing from all. But amidst this war, contention, and discord, you may find everywhere, throughout the whole world, one uniform law and opinion, that there is **ONE GOD, THE KING AND FATHER OF ALL**, and many gods, the **SONS OF GOD**, who reign with God. These things both the Greek and barbarian affirm, both the inhabitants of the continent and of the sea-coast, both the wise and the unwise."

This account of philosophical polytheism receives no ³⁶Indian Bra-
min. small support from the Asiatic Researches of Sir William Jones. "It must always be remembered (says that accomplished scholar), that the learned Indians, as they are instructed by their own books, acknowledge only

fore it is not one only dispenser of things, who, as it were, out of several vessels distributeth these several liquors of good and evil, mingling them together, and dashing them as he pleases; but there are two distinct and contrary powers or principles in the world, one of them always leading, as it were, to the right hand, but the other tugging the contrary way. For if nothing can be made without a cause, and that which is good cannot be the cause of evil, there must needs be a distinct principle in nature for the production of evil as well as good."

That this is palpable manicheism (see **MANICHEISM**), appears to us so very evident, as to admit of no debate. It appeared in the same light to the learned Cudworth; but that author labours to prove that Plutarch mistook the sense of Pythagoras, Empedocles, Heraclitus, Anaxagoras, and Plato, when he attributed to them the same opinions which were held by himself. Mosheim, on the other hand, has put it beyond a doubt, that whatever was Plutarch's belief respecting the origin of evil and the existence of two independent principles, it was taken implicitly from the writings of Plato. But the pious chancellor of *Göttingen*, actuated by the same motives with Cudworth, wishes to persuade his readers, that by Plato and Plutarch nothing *active* was understood by their evil principle but only *that tendency to confusion*, which was then deemed inseparable from matter. But that something more was meant seems undeniable; for immediately after the words which we have quoted, Plutarch proceeds to affirm that the wisest men declare *θεοὺς εἶναι δύο κατὰ τὴν ἀντίθετον*, *that there are two gods, as it were of contrary trades or crafts*, of which one is the author of all good and the other of all evil. See *Mosheim. ed. Cudworth. System. Intellect. lib. i. cap. 4. § 13.*

Theogony. only one supreme Being, whom they call BRAHME, or THE GREAT ONE, in the neuter gender. They believe his essence to be infinitely removed from the comprehension of any mind but his own; and they suppose him to manifest his power by the operation of his divine spirit, whom they name VISHNOU the pervader, and NE'RA'YAN or moving on the waters, both in the masculine gender; whence he is often denominated the *first male*. When they consider the divine power as exerted in creating or giving existence to that which existed not before, they call the deity BRAHMA'; when they view him in the light of *destroyer*, or rather *changer of forms*, they give him a thousand names, of which SIVA, ISWARA, and MAHADEVA, are the most common; and when they consider him as the preserver of created things, they give him the name of VISHNOU. As the soul of the world, or the pervading mind, so finely described by Virgil, we see JOVE represented by several Roman poets; and with great sublimity by Lucan in the well known speech of Cato concerning the Ammonian oracle. 'Jupiter is wherever we look, wherever we move.' This is precisely the Indian idea of VISHNOU: for since the power of preserving created things by a superintending providence belongs eminently to the godhead, they hold that power to exist transcendentally in the *preserving* member of the triad, whom they suppose to be EVERYWHERE ALWAYS, not in substance, but in spirit and jenergy." This supreme god BRAHME, in his triple form, is the only self-existent divinity acknowledged by the philosophical Hindoos. The other divinities GENESA, INDRA, CUVERA, &c. are all looked upon either as his creatures or his children; and of course are worshipped only with inferior adoration.

37
Why the philosophers worshipped the inferior divinities.

It was upon this principle of the generation of the gods, and of their acting as ministers to the supreme *Numen*, that all the philosophers of Greece, who were not atheists, worshipped many divinities, though they either openly condemned or secretly despised the traditions of the poets respecting the amours and villanies of Jupiter, Venus, Mercury, and the rest of the tribe. It was the same principle sincerely admitted, and not an ill-timed jest, as has been absurdly supposed, that made Socrates, after he had swallowed the poison, request his friend to offer a votive cock for him to Esculapius.

But a theogony was not peculiar to the Greeks, Romans, and the Hindoos; it made part of every system of polytheism. Even the Egyptians themselves, the grossest of all idolaters, believed in one self-existing God, from whom all their other divinities descended by generation. This appears probable from the writings of Horus Apollo, Jamblicus, Porphyry, and many other ancient authors; but if the inscription on the gates of the temple of *Neith* in *Sais*, as we have it from Plutarch and Proclus, be genuine, it will admit of no doubt. This famous inscription, according to the last of these writers, was to this purpose: "I am whatever is, what-

ever shall be, and whatever hath been. My veil no man hath removed. The offspring which I brought forth was the sun (E)"

The Persian magi, as we have seen, believed in two self-existent principles, a good and an evil: but if Diogenes Laertius deserves to be credited, they held that fire, earth, and water, which they called gods, were generated of these two. It was observed in the beginning of this article, that the first object of idolatrous worship was probably the sun, and that this species of idolatry took its rise in Chaldea or Persia. But when it became the practice of eastern monarchs to conceal themselves wholly from their people, the custom, as implying dignity, was supposed to prevail as well in heaven as on earth; and Zoroaster, the reformer of the Persian theology, taught*, that "Ormuzd was as far removed from the sun as the sun is removed from the earth." According to this modification of magianism, the sun was one of the generated gods, and held the office of prime minister or vicegerent to the invisible fountain of light and good. Still, however, a self-existent principle of evil was admitted; but though he could not be destroyed or annihilated by any power, it was believed that he would at last be completely vanquished by Ormuzd and his ministers, and rendered thenceforward incapable of producing any mischief.

From this short view of polytheism, as we find it delineated by the best writers of antiquity, we think ourselves warranted to conclude, that the whole pagan world believed in but *one*, or at most *two*, SELF-EXISTENT GODS, from whom they conceived all the other divinities to have descended in a manner analogous to human generation. It appears, however, that the vulgar pagans considered each divinity as supreme and unaccountable within his own province, and therefore intitled to worship, which rested ultimately in himself. The philosophers, on the other hand, seem to have viewed the inferior gods as accountable for every part of their conduct to him who was their fire and sovereign, and to have paid to them only that inferior kind of devotion which the church of Rome pays to departed saints. The vulgar pagans were sunk in the grossest ignorance, from which statesmen, priests, and poets, exerted their utmost influence to keep them from emerging; for it was a maxim which, however absurd, was universally received, that "there were many things true in religion", which it was not convenient for the vulgar to know; and some things which, though false, it was yet expedient that they should believe." The polytheism and idolatry of the vulgar, therefore, was their misfortune rather than their fault. But the philosophers were wholly "without excuse"; because that when they knew God, they glorified him not as God, neither were thankful, but became vain in their imaginations, and their foolish heart was darkened. Professing themselves wise, they became fools, and worshipped and served the creature more than the Creator, who is God blessed for ever."

POLY.

(E) Τα πάντα, και τα εσομενα, και τα γεγονοτα, εγω ειμι. Τον εμον χιτωνά ουδεις απεκαλυψεν. 'Ον εγω καρπον ετεκον, ήλιος ενεβη. The antiquity of this inscription is admitted by Cudworth, denied by Mosheim, and doubted by Jablonski. The reader who wishes to know their arguments may consult Mosheim's edition of the *Intellectual System*, and Jablonski's *Pantheon Egyptiorum*.

Polytrichum.

POLYTRICHUM, in botany: A genus of the order of musci, belonging to the cryptogamia class of plants. The anthera is operculated, and placed upon a very small apophysis or articulation; the calyptra villos; the star of the female is on a distinct individual. There are three species; the most remarkable of which is the commune, or great golden maiden-hair, frequently to be met with in the bogs and wet places of this country. It grows in patches, the stalks erect, generally single and unbranched, from three inches to a foot, or even a yard high. The leaves are numerous, stiff, lanceolate, acute, growing round the stalk without order, and, if viewed with a microscope, appear to have their edges finely serrated. They are of a bright green when young and fresh, but reddish when dried or in decay: the filaments, or peduncles, are of a shining red, or orange colour, from two to four inches long, arising singly from the top of the stalks, and surrounded at their base with a cylindrical tubular vagina, or perichætium. The anthera, or capsule, is quadrangular, green at first, afterwards yellow, and red when ripe, having an annular pedestal, or apophysis, at its base. The operculum is flat, with a projecting point in the centre; and underneath is a whitish circular membrane, placed in the middle of the capsule's orifice, and sustained there by numerous arched threads, or cilia, connected by one end to the circumference of this membrane, and by the other fastened to the ring of the anthera. The pollen, or, as others term it, the seed, is freed from the anthera or capsule through the space between the cilia. The calyptra is twofold, an internal and external one; both which at first entirely cover and hang over the anthera. The internal one is conical, membranaceous, and smooth; the external one is composed only of tawny hairs, connected into a sort of mat, lacerated at the base, and serving like a roof of thatch to defend the other. Besides the stalks before described, there are commonly some others near at hand, which are destitute both of filaments and capsules, but are terminated with a kind of rosaceous cup, either of a bright red or yellowish colour, composed of leaves of different sizes, the outermost broad, the innermost lanceolate, growing gradually more and more fine and slender to the centre. This cup is looked upon by Linnæus as the female flower of this moss; but Haller is of opinion, that it is only the gem or origin of a new stalk, which frequently rises from its centre, and this again becomes sometimes proliforous. There are two varieties of this moss: the first has much shorter stalks than the preceding, and often branched; the leaves stiffer, erect, and more crowded; in other respects the same. The other has a stalk scarcely more than half an inch high, terminated with a cluster of linear, erect, rigid leaves, for the most part entire on the edges, and tipped each with a white hair. The filament is about an inch high, and the capsule quadrangular. The female flower, or gem, is of a bright red colour.

The first kind, when it grows long enough for the purpose, is sometimes used in England and Holland to make brooms or brushes. Of the female sort the Laplanders, when obliged to sleep in desert places, frequently make a speedy and convenient bed. Their manner of doing it is curious: Where this moss grows thick together, they mark out, with a knife, a piece of

ground, about two yards square, or of the size of a common blanket; then beginning at one corner, they gently sever the turf from the ground, and as the roots of the moss are closely interwoven and matted together, they by degrees strip off the whole circumscribed turf in one entire piece; afterwards they mark and draw up another piece, exactly corresponding with the first; then, shaking them both with their hands, they lay one upon the ground, with the moss uppermost, instead of a mattress, and the other over it, with the moss downwards, instead of a rug; and between them both take a comfortable nap, free from fleas and bugs, and without fear of contagious distempers. It is probable they might take the hint of making such a bed from the bear, a cohabitant of their country, which prepares his winter-quarters with a large collection of this same moss. See *MUSCI*, p. 473. and Plate CCCXXI.

POLYXÆNUS, or **POLYÆNUS**. See **POLYÆNUS**.

POLYXO, a priestess of Apollo's temple in Lemnos. She was likewise nurse to queen Hypsipyle. It was by her advice that the Lemnian women murdered all their husbands. — There was another Polyxo, a native of Argos, who married Tlepolemus son of Hercules. She followed him to Rhodes after the murder of his uncle Licynnius; and when he departed for the Trojan war with the rest of the Greek princes, she became the sole mistress of the kingdom. After the Trojan war, Helen fled from Peloponnesus to Rhodes, where Polyxo reigned. Polyxo detained her; and to punish her as being the cause of a war in which Tlepolemus had perished, she ordered her to be hanged on a tree by her female servants, disguised in the habit of Furies.

POMACEÆ, (*pomum* "an apple,") the name of the 36th order in Linnæus's Fragments of a Natural Method, the genera of which have a pulpy esculent fruit of the apple, berry, and cherry kind. See **BOTANY**, Sect. vi. p. 465.

POMATUM, an unguent generally used in dressing the hair. It is also used as a medicine. See **PHARMACY**, n° 636, &c.

POMEGRANATE. See **PUNICA**.

POMERANIA, a province of Germany, in the circle of Upper Saxony, with the title of a duchy. It is bounded on the north by the Baltic Sea, on the east by Prussia and Poland, on the south by the marquisate of Brandenburg, and on the west by the duchy of Mecklenburg; and is about 250 miles in length, and in some places 75 miles and in others 50 in breadth. It is watered by several rivers, the most considerable of which are the Oder, the Pene, the Rega, the Persant, the Wipper, the Stolp, the Lupo, and the Lobo. The air is cold; but the soil abounds in pastures, and produces corn, of which a great deal is exported. It is a flat country; containing many lakes, woods, and forests, and has several good harbours. It is divided into the Hither and Farther Pomerania, and the territories of the kings of Sweden and Prussia in this duchy are divided by the river Pene.

POMET (Peter), an able druggist at Paris, was born in 1658. He collected at a great expence from all countries drugs of every kind, and rendered himself celebrated by his book entitled *Histoire Generale des Drogues*,

Polyxeno
Il
Pomet.

Vishnu.



Brahma.

Isvara.



The Principal Idols of the Saxons worshipped in Britain.



Pomfret
||
Pommer-
culia

Druguet, which is the most complete book on the subject that has yet been printed. He gave demonstrations with respect to his drugs in the king's garden, and a catalogue of all the drugs contained in his work, with a list of all the rarities of his cabinet, which he proposed to publish by subscription; but was prevented by his death, which happened in 1699, upon the very day when the patent for a pension granted him by Louis XIV. was made out.

POMFRET (John), an English poet, son of the rector of Luton in Bedfordshire, was born in 1667, and educated at Cambridge; after which he took orders, and was presented to the living of Malden in Bedfordshire. About 1703 he went to London for institution to a larger and very considerable living; but was stopped some time by Compton, then bishop of London, on account of these four lines of his poem, entitled the Choice:

"And as I near approach'd the verge of life,
Some kind relation (for I'd have no wife)
Should take upon him all my wordly care,
While I did for a better state prepare."

The parentheses in these lines were so maliciously represented, that the good bishop was made to believe that Pomfret preferred a mistress to a wife. But he was soon convinced that this representation was the mere effect of malice, as Pomfret at that time was actually married. The opposition, however, which his slanderers had made to him had its effect; for, being by this obliged to stay in London longer than he intended, he caught the smallpox, and died of it, aged 35.

He published a volume of his poems in 1699, with a very modest and sensible preface. Two pieces of his were published after his death by his friend Philaethes; one intitled Reason, and written in 1700, when the disputes about the Trinity ran high; the other *Dies Novissima*, or the "Last Epiphany," a Pindaric ode. His versification is not unamusing; but there is not the force in his writings which is necessary to constitute a poet. A dissenting teacher of his name, and who published some rhymes upon spiritual subjects, occasioned fanaticism to be imputed to him; but his friend Philaethes has justly cleared him from the imputation. Pomfret had a very strong mixture of devotion in him, but no fanaticism.

"The Choice (says Dr Johnson) exhibits a system of life adapted to common notions, and equal to common expectations; such a state as affords plenty and tranquillity, without exclusion of intellectual pleasures. Perhaps no composition in our language has been oftener perused than Pomfret's Choice. In his other poems there is an easy volubility; the pleasure of smooth metre is afforded to the ear, and the mind is not oppressed with ponderous, or intangled with intricate, sentiment. He pleases many; and he who pleases many must have merit."

POMME, or POMMETTE, in heraldry, is a cross with one or more balls or knobs at each of the ends.

POMMEL, or PUMMEL, in the manege, a piece of brass or other matter at the top and in the middle of the saddle-bow.

ROMMERCULLIA, in botany: A genus of the

monogynia order, belonging to the triandria class of *Pomœrium* plants; and in the natural method ranking under the 4th order, *Gramina*. The calyx is bivalved, and shaped like a top; the valvula quadrifid, and bearded on the back. The corolla has two unequal valves; the filaments three, with long pointed antheræ; the style simple. The whole flower forms itself into a sharp point, and the corolla serves as a covering to the seed, which is long, clear, and smooth. There is only one species, viz. the *Dianthoides*.

POMCERIUM, in Roman antiquity, was, according to Livy, that space of ground, both within and without the walls, which the augurs, at the first building of cities, solemnly consecrated, and on which no edifices were allowed to be raised. Plutarch gives this account of the ceremony of drawing the pomœrium: "They dug a trench, and threw into it the first-fruits of all things, either good by custom, or necessary by nature; and every man taking a small turf of earth of the country from whence he came, they cast them in promiscuously. Then making this trench their centre, they described the city in a circle round it. After this, the founder yoking a bull and a cow together, ploughed a deep furrow, with a brazen ploughshare, round the bounds. The attendants took care that all the clouds fell inwards, i. e. toward the city. This furrow they called *pomarium*, and built the wall upon it."—Plutarch, in this account, is to be understood as speaking of Rome.

POMERIUM Proferre, signifies to extend or enlarge a city, which could not be done by any, but those who had taken away some part of an enemy's country in war. But this qualification was sometimes dispensed with. *Pomarium* is *quasi pone mœnia*, "behind the walls."

POMONA, in fabulous history, the tutelary deity of orchards and fruit-trees. See VERTUMNUS.

POMPEII (anc. geog.), a town of Campania near Herculaneum, and destroyed along with it by the great eruption of Vesuvius in the time of Titus. See HERCULANEUM. It is about 15 miles from Naples, and six or seven from Portici—So much has been said and written on the discovery of this place, as makes it unnecessary for us to say much: we shall therefore only give a short extract on the subject from an anonymous work lately published, apparently of considerable merit. "On entering the city (says our author ||), the first object is a pretty square, with arcades, after the present manner of Italy. This was, as it is imagined, the quarter of the soldiers; numbers of military weapons being found here.

"A narrow, but long street, with several shops on each side, is now perfectly cleansed from its rubbish, and in good preservation. Each house has a court. In some of them are paintings *al fresco*, principally in *chiaroscuro*; and their colours not in the least injured by time. The few colours which the ancients knew were extracted only from minerals; and this may be a sufficient reason for their freshness. The street is paved with irregular stones of a foot and half or two feet long, like the Appian way.

"In discovering this city, it was at first doubted whether it were actually Pompeii: but the name inscribed over the gateway put it beyond all doubt. The

skeletons

|| Comparison
of the Sketch
of England
and Italy,
with Dis-
quisitions on
National
Advantages

Pompey
||
Pompona-
tius.

skeletons found were innumerable, It is said that many had spades in their hands, endeavouring, probably at first, to clear away the torrent of ashes with which they were deluged. Indeed the satisfaction which is felt at the view of ancient habitations, is much allayed by inevitable reflections on this frightful scene of desolation, though at the distance of so many centuries.

"An ancient villa is also seen entire at a little distance from Pompeii. The house is really elegant and spacious, but only two stories high. The pavement of the chambers is composed of tessellated marble, and, when polished, displays the design perfectly well.—There is some at the museum of Portici brought from this place, which the eye would really mistake for painting. Under the house is a fine triangular cellar, of which each part is 100 feet long, well filled with amphoræ. The skeletons of 29 persons were found here, supposed to have fled to it for safety. Each house is filled with ashes: they have almost penetrated through every crevice; and it is incredible how such a volume of them could have been thrown out by Vesuvius with sufficient force to have reached so far." See Swinburne's *Travels in the Two Sicilies*, vol. 2. p. 98, &c.; Lady Miller's *Letters*, or *De La Lande*; Captain Sutherland's *Tour up the Straits, from Gibraltar to Constantinople*, p. 75. &c.; Dr Smith's *Sketch of a Tour on the Continent*, in 1786 and 1787, vol. 2. p. 118, &c.; and Watkins's *Tour through Switzerland, Italy, &c.*

POMPEY the GREAT, (Cneius Pompeius Magnus), the renowned rival of Julius Cæsar. Being defeated by him at the battle of Pharsalia, owing to the defection of his cavalry, he fled to Egypt by sea, where he was basely assassinated by order of Theodotus, prime minister to Ptolemy the Younger, then a minor,

See *Rome*. 48 B. C.*

POMPEYS (Cneius and Sextus), his sons, commanded a powerful army when they lost their illustrious father. Julius Cæsar pursued them into Spain, and defeated them at the battle of Munda, in which Cneius was slain, 45 B. C. Sextus made himself master of Sicily; but being defeated in the celebrated naval engagement at Actium by Augustus and Lepidus, he fled to Asia with only 7 ships, the remains of his fleet, which consisted of more than 350; and from thence, unable to continue the war, he was obliged to retire to Lesbos, where renewing the war by raising an army, and seizing on some considerable cities, Marcus Titius, in the interest of Marc Antony, gave him battle, defeated him, took him prisoner, and basely put him to death, 35 B. C. See *ROME*.

POMPEY'S-Pillar. See *ALEXANDRIA*, p. 393.

POMPILUS, in ichthyology, a species of CORYPHOENA.

POMPONATIUS (Peter), an eminent Italian philosopher, was born at Mantua in 1462. He was of so small a stature, that he was little better than a dwarf; yet he possessed an exalted genius, and was considered as one of the greatest philosophers of the age in which he lived. He taught philosophy, first at Padua and afterwards at Bologna, with the highest reputation. He had frequent disputations with the celebrated Achillini, whose puzzling objections would have confounded him, had it not been for his skill in parrying them by some joke. His book *De Immortalitate Animæ*, published in 1516, made a great noise. He maintained, that the immortality of

the soul could not be proved by philosophical reasons; but solemnly declared his belief of it as an article of faith. This precaution did not, however, save him; many adversaries rose up against him, who did not scruple to treat him as an atheist; and the monks procured his book, although he wrote several apologies for it, to be burnt at Venice. His book upon Incantations was also thought very dangerous. He shows in it, that he believed nothing of magic and sorcery; and he lays a prodigious stress on occult virtues in certain men, by which they produced miraculous effects. He gives a great many examples of this; but his adversaries do not admit them to be true, or free from magic.—Paul Jovius says, that he died in 1525, in his grand climacteric. He was three times married; and had but one daughter, to whom he left a large sum of money. He used to apply himself to the solution of difficulties so very intensely, that he frequently forgot to eat, drink, sleep, and perform the ordinary functions of nature: nay, it made him almost distracted, and a laughing-stock to every one, as he himself tells us.

POMPONIUS MELA. See *MELA*.

POMUM, an APPLE; a species of seed-vessel, composed of a succulent fleshy pulp; in the middle of which is generally found a membranous capsule, with a number of cells, or cavities, for containing the seeds. Seed-vessels of this kind have no external opening or valve. At the end opposite to the foot-stalk is frequently a small cavity, called by the gardeners the *eye of the fruit*, and by botanists *umbilicus*, the "navel," from its fancied resemblance to the navel in animals. Gourd, cucumber, melon, pomegranate, pear, and apple, furnish instances of the fruit or seed-vessel in question.

POND, or FISH-POND. See *FISH-PONDS*.

POND, is a small pool or lake of water from whence no stream issues. In the *Transactions of the Society instituted at London for the Encouragement of Arts, Manufactures, and Commerce*, vol. viii. and printed in the year 1790, there is a short account of a machine for draining ponds without disturbing the mud. It was communicated to the society, together with a drawing and model of the machine, by Lieutenant-colonel Dansey. The model was made from the description of a machine used by a gentleman near Taunton for many years before, for supplying a cascade in his pleasure-grounds.—The colonel's regiment was then lying at Windsor; and thinking that the invention might be useful to supply the grand cascade at Virginia-water, he made the model, and presented it to the king, who was graciously pleased to approve of it. In consequence of which, by his majesty's desire, a penstock on that principle was constructed from the model at one of the ponds in the neighbourhood.—The colonel thinks the machine may be useful in the hands of men of science, and applicable to silk, cotton, and other mills, where a steady and uniform velocity of water is wanted; which might be regulated at pleasure, occasioning no current to disturb the mud or fish, as the stream constantly runs from the surface. He says he has often made the experiment by the model in a tub of water.

Of this machine we have given an engraving, taken from the above-mentioned Transactions; and we shall now add the description which accompanies the plate in that work.

In figure 1. A is the pipe, loaded with a rim of lead, Plate of CCCCXII

Pomponius
||
Pond.

Pond
||
Pong.

of such weight as serves to sink it below the surface of the water. B is the discharging pipe, laid through the bank HI. C is the joint on which the pipe A turns its form, which is shown fig. 2. D is the ball or float, which, swimming on the surface of the pond, prevents the pipe A from descending deeper than the length of the chain by which they are connected. E is a chain winding on the windlafs F, and serving to raise the tube A above the surface of the water, when the machinery is not in use. G is a stage. III is the bank, represented as if cut through at I, to show the tube B lying within it. K is a post to receive the tube A when lowered, and to prevent its sinking in the mud. In figure 2. A is a cast cylinder, with a plate or check, B, which is fastened to the timber of the tube on one side, but not on the other, as the part of the cylinder C turns in the hollow of the wooden tube when it is immersed. A piece of strong sole leather is put inside the brass-plate B, to prevent leaking.

Pond-Weed, in botany. See POTAMOGETON.

PONDICHERY, is a large town of Asia, in the peninsula on this side the Ganges, and on the coast of Coromandel. Its situation is low, and the ships anchor about a mile and a half from it; nor can the boats or canoes come nearer it than a musket-shot, on account of the breakers, so that the blacks come in flat-bottomed boats to carry the men and merchandises to the fleet. The fort is 200 paces from the sea, and very irregular; built with bricks, and covered with fine plaster, resembling white marble. The huts of the blacks lie here and there, and the walls are of bamboos mixed with the branches of trees. The French are greatly addicted to women, from whom they catch diseases that render them pale, livid, and meagre, with a frightful aspect. However, several of the French are married to a sort of Portuguese women, who are of a mixed breed, being a kind of Mulattoes. The country about it is barren, and consequently most of their provisions are brought from other places. Their trade consists of cotton-cloth, silks, pepper, saltpetre, and other merchandises that are brought from Bengal. With regard to the religion of the natives, the most numerous are the Gentoos; but there are Mahometans or Moors who hold a great many ridiculous opinions. The Gentoos are of different sects, and that of the Brahmins are priests. The custom of women burning themselves with the bodies of their dead husbands was very common, but of late much discountenanced. The slaves or servants are very numerous, and their chief food is rice. This place was taken, and the fortifications demolished, by Colonel Coote; it was restored to the French by the peace of 1763; and was retaken in the beginning of the present war with the French republic. It is 60 miles south of Fort St George. E. Long. 79. 58. N. Lat. 11. 42.

PONDICO, an island of the Archipelago, lying on the gulph of Ziton, near the coast of Negropont. It is small and uninhabited, as well as two others that lie near it.

PONG-HOU *Isles*, in the province of Fo-kien in China, form an archipelago between the port of Emouy and the island of Formosa. A Chinese garrison is kept here, with one of those mandarines who are called *literati*, whose principal employment is to watch the trad-

Vol. XV. Part I.

ing vessels which pass from China to Formosa, or from Formosa to China.

As these islands are only sand-banks or rocks, the inhabitants are obliged to import every necessary of life; neither shrubs nor bushes are seen upon them; all their ornament consists of one solitary tree. The harbour is good, and sheltered from every wind; it has from 20 to 25 feet depth of water. Although it is an uncultivated and uninhabited island, it is absolutely necessary for the preservation of Formosa, which has no port capable of receiving vessels that draw above eight feet of water.

PONIARD, a little pointed dagger, very sharp edged; borne in the hand, or at the girdle, or hid in the pocket. The word is formed from the French *poignard*, and that from *poignée*, "handful."—The poniard was anciently in very great use; but it is now in a good measure set aside, except among assassins.—Sword and poniard were the ancient arms of duellists; and are said to continue still so among the Spaniards. The practice of sword and poniard still make a part of the exercise taught by the masters of defence.

PONS, a town of France, in Saintonge, very famous in the time of the Huguenots. It is seated on a hill, near the river Suigne, 10 miles from Saintes. W. Long. 30. N. Lat. 45. 36.

PONT-DU-GARD, is a bridge of France, in Lower Languedoc, built over the river Gardon, which served for an aqueduct. It is a very remarkable and a most magnificent work, and was raised by the ancient Romans. It consists of three bridges, one above another; the uppermost of which was the aqueduct, to convey water to the city of Nîmes, which is eight miles to the south. They are altogether 192 feet high, and the uppermost 580 feet long. They are constructed between two rocks. E. Long. 4. 26. N. Lat. 43. 58.

PONTEDERIA, in botany: A genus of the monogynia order, belonging to the hexandria class of plants; and in the natural method ranking under the sixth order, *Enfuta*. The corolla is monopetalous, sexfid, bilabiate; there are three stamina inserted into the top, and three into the tube of the corolla; the capsule is bilocular.

PONTEFRAC, or POMFRET, a town of the West Riding of Yorkshire in England, situated on the river Aire. It is said to take its name from a broken bridge, which is supposed to have been laid anciently over that marshy spot called the *Wash*. Here are the ruins of a noble old castle, where Richard II. was barbarously murdered, and two of Edward V.'s uncles. The collegiate chapel of St Clement, which had a dean, three prebendaries, &c. is still distinguishable in it. This town has a good market, and fairs for horses, sheep, and other cattle. It is a corporation, governed by a mayor, recorder, aldermen, and burgesses, and gives title of earl to the family of Fermor. In the reign of Queen Elizabeth, 200 l. was left by George Talbot, earl of Shrewsbury, to be lent for ever, at 5 l. a time, on proper security, for three years, to the poor artificers of the town; and Thomas Wentworth, Esq; ancestor to the marquis of Rockingham, left 200 l. to the charity-school. A branch of the great Roman military way called *Erminstreet*, which passed from Lincoln to York, may be traced betwixt

Y y

this

Pontifex town and Doncaster. The adjacent country yields plenty of limestone, together with liquorice and skirrets. W. Long. 1. 5. N. Lat. 53. 42.

PONTIFEX, PONTIFF, or High-priest, a person who has the superintendence and direction of divine worship, as the offering of sacrifices and other religious solemnities. The Romans had a college of pontiffs; and over these a sovereign pontiff, or pontifex maximus, instituted by Numa, whose function it was to prescribe the ceremonies each god was to be worshipped withal, compose the rituals, direct the vestals, and for a good while to perform the business of augury, till, on some superstitious occasion, he was prohibited intermeddling therewith. The office of the college of pontiffs was to assist the high-priest in giving judgment in all causes relating to religion, inquiring into the lives and manners of the inferior priests, and punishing them if they saw occasion, &c. The Jews too had their pontiffs; and among the Romanists, the pope is still styled the *sovereign pontiff*.

PONTIFICATE, is used for the state or dignity of a pontiff or high-priest; but more particularly in modern writers for the reign of a pope.

PONTIUS (Pilate.) See **PILATE**.

PONTON, or PONTOON, in war, a kind of flat bottomed boat, whose carcase of wood is lined within and without with tin: they serve to lay bridges over rivers for the artillery and army to march over. The French pontoons, and those of most other powers, are made of copper on the outside: though these cost more at first, yet they last much longer than those of tin; and when worn out, the copper sells nearly for as much as it cost at first; but when ours are rendered useless, they sell for nothing. Our pontoons are 21 feet long, five feet broad, and depth within two feet 1.5 inches.

PONTOON-Carriage, is made with two wheels only, and two long side-pieces, whose fore-ends are supported by a limber; and serves to carry the pontoon, boards, cross-timbers, anchors, and every other thing necessary for making a bridge.

PONTOON-Bridge, is made of pontoons slipped into the water, and placed about five or six feet asunder; each fastened with an anchor, when the river has a strong current; or to a strong rope that goes across the river, running through the rings of the pontoons. Each boat has an anchor, cable, baulks, and chests. The baulks are about five or six inches square, and 21 feet long. The chests are boards joined together by wooden bars, about three feet broad and 12 feet long. The baulks are laid across the pontoons at some distance from one another, and the chests upon them joined close; which makes a bridge in a very short time, capable of supporting any weight.

PONT St ESPRIT, is a town of France, in Languedoc, in the diocese of Ufiez. It is seated on the river Rhone, over which is one of the finest bridges in France. It is 840 yards long, and consists of 26 arches. Each

pier is pierced with an aperture, in order to facilitate the passage of the water where the river is high. The town is large, but the streets are narrow and ill-built. It formerly contained several churches and convents. It is 17 miles south of Viviers, and 55 north-east of Montpelier. E. Long. 4. 46. N. Lat. 44. 13.

PONTUS, the name of an ancient kingdom of Asia, originally a part of Cappadocia; bounded on the east by Colchis, on the west by the river Halys, on the north by the Euxine Sea, and on the south by Armenia Minor. Some derive the name of Pontus from the neighbouring sea, commonly called by the Latins *Pontus* of the *Euxinus*; others from an ancient king named *Pontus*, who imparted his name both to the country and the sea; but Bochart deduces it from the Phœnician word *botno*, signifying a filberd, as if that nut abounded remarkably in this place. But this derivation seems to be very far fetched; and the common opinion that the country derived its name from the sea, seems by far the most probable. The kingdom was divided into three parts; the first, named *Pontus Galaticus*, extending from the river Halys to the Thermodon; the second, named *Pontus Polemoniacus*, extended from the Thermodon to the borders of *Pontus Cappadocius*; and this last extended from Pontus Polemoniacus to Colchis, having Armenia Minor and the upper stream of the Euphrates for its southern boundary.

It is commonly believed, that the first inhabitants of Pontus were descended from Tubal; but in process of time mixed with Cappadocians, Paphlagonians, and other foreign nations, besides many Greek colonies which settled in those parts, and maintained their liberty till the time of Mithridates the Great and Pharnaces. The first king of this country whom we find mentioned in history is Artabazes, who had the crown bestowed on him by Darius (A) Hytaspes. The next was Rhodobates, who reigned in the time of Darius Nothus. After him came Mithridates, who, refusing to pay the usual tribute to the Persians, was defeated by Artaxerxes Mnemon; but a peace was soon after concluded by the mediation of Tissaphernes. Besides this, we hear nothing of him farther than that he was treacherously taken prisoner by Clearchus afterwards tyrant of Heraclea, and obliged to pay a large sum for his ransom.

Mithridates I. was succeeded by Ariobarzanes, who being appointed by Artaxerxes governor of Lydia, Ionia, and Phrygia, employed the forces that were under his care in the extending of his own dominions, and subduing those of his natural prince. The king of Persia sent one Autophrodates against him; but Ariobarzanes, having with great promises prevailed on Agésilas and Timothæus the Athenian to come to his assistance, obliged Autophrodates to retire. He then rewarded Agésilas with a great sum of money, and bestowed on Timothæus the cities of Sestos and Abydos, which he had lately taken from the Persians. He used his utmost endeavours to reconcile the Lacedæmonians and Thebans; but not being able to bring the latter

Pontus.

¹ Etymology of the name.

² Artabazes the first king.

³ Mithridates.

(A) This country, together with the adjacent provinces, was in different periods under the dominion of the Assyrians, Medes, and Persians; the last of whom divided Cappadocia into satrapies or governments, and bestowed that division which was afterwards called *Pontus* on one of the ancestors of Mithridates. This regulation was effected in the reign of Darius the son of Hytaspes, and has been regarded as the date of the kingdom.

Pontus.

to any reasonable terms, he assisted the Lacedemonians with vast sums of money. The Athenians showed so much respect for this prince, that they not only made him free of their city, but granted both him and his children whatever they asked of them. He was murdered in the 28th year of his reign by one Mithridates, whom authors suppose to have been his son. This happened at the time that Alexander the Great invaded Asia, so that Pontus for a time fell under the power of the Macedonians.

4
Ariobarzanes shakes off the Macedonian yoke.

In the reign of Antigonus, Mithridates the son of Ariobarzanes shook off the Macedonian yoke; the particulars of which event are related as follow. Antigonus having dreamed that he had a field in which gold grew after the manner of corn, and that Mithridates cut it down and carried it into Pontus, began to be very jealous of him, and ordered him to be put to death privately. But Mithridates, having got notice of the king's intention, withdrew into Paphlagonia, attended only by six horsemen. Here, being joined by many others, he possessed himself of Ciniatum, a strong hold situated near mount Olgafys; from whence, as his army continually increased, he made an irruption into Cappadocia; and having driven the commanders of Antigonus from that part which borders upon Pontus, he entered his paternal kingdom, which, in spite of the utmost efforts of Antigonus, he held for the space of 26 years, and transmitted to his posterity.

Under the reigns of Mithridates III. Ariobarzanes II. and Mithridates IV. the immediate successors of Mithridates II. nothing remarkable happened. But Mithridates V. made war on the inhabitants of Sinope, a city on the coast of Paphlagonia. He made himself master of all the adjacent places; but finding the whole peninsula, on which Sinope itself stood, well fortified and garrisoned, not only by the inhabitants, but by their allies the Rhodians, he abandoned the enterprise. He afterwards proved a great friend to the Rhodians, and assisted them with money to repair the losses they had sustained by an earthquake. He entered also into a strict alliance with Antiochus the Great, who married one of his daughters named *Laodice*.

5
Pharnaces I. differs with the Romans.

After the death of Mithridates V. his son Pharnaces I. attacking the city of Sinope, unexpectedly took it by storm. On this the Rhodians sent ambassadors to Rome, complaining of the behaviour of the king of Pontus; but Pharnaces was so far from being intimidated by their threats, that he invaded the territories of Eumenes their great ally. The latter sent ambassadors to Rome, and entered into an alliance with Ariarathes king of Cappadocia. Pharnaces, in his turn, sent ambassadors to Rome, complaining of Eumenes and Ariarathes; upon which some Romans were sent into Asia to inquire into the state of matters. These found Eumenes and his associates willing to accommodate the difference, but Pharnaces in a quite opposite disposition, which they accordingly reported at Rome.

6
Concludes a most disadvantageous peace.

In the mean time a war was commenced between Eumenes and Pharnaces; but the latter, being disappointed of assistance from Seleucus king of Syria, whom the Romans would not allow to join him, was at last forced to sue for peace; which was granted him upon the following conditions: That he should forthwith withdraw his forces from Galatia, and disannul all engagements and alliances with the inhabitants of that

country; that he should in like manner evacuate Paphlagonia, and send back such as he had from thence carried into slavery; that he should restore to Ariarathes all the places which he had taken during the war, the hostages of both kings, all their prisoners without ransom, and moreover should deliver up to them such of their subjects as from the first breaking out of the war had fled to him; that he should return to Morzias, a petty king in these parts, and to Ariarathes, 900 talents which he had seized in the war, and pay down 300 more to Eumenes as a fine for invading his dominions without provocation. Mithridates, king of Armenia, having in this war joined Pharnaces, was, by the articles of the treaty, obliged to pay 300 talents to Ariarathes for having assisted his enemy contrary to an alliance at that time subsisting between them. Soon after Pharnaces died, and left the kingdom to his son Mithridates VI. more weakened by this peace than by the most destructive war.

The new king entered into an alliance with the Romans, and proved such a faithful friend, that he was rewarded by the senate with Phrygia Major, and honoured with the title of the friend and ally of the people of Rome. After a long and prosperous reign, he was murdered by some of his intimate acquaintance, and was succeeded by his son Mithridates VII. surnamed the *Great*.

7
His son enters into alliance with the Romans.

The new prince, though not exceeding 13 years of age, began his reign with most inhuman acts of cruelty to his mother and nearest relations. His father, by his last will, had appointed him and his mother joint heirs to the kingdom; but he, claiming the whole, threw her into prison, where she soon died through the hard usage she met with. Those to whom the care of his education was committed, observing him to be of a cruel and unruly temper, made various attempts on his life, but could never effect their design, as the king was always on his guard, and armed, in that tender age, against all kind of treachery, without showing the least diffidence.

8
His extraordinary qualities.

In his youth Mithridates took care to inure himself to hardships, passing whole months in the open air, employed in the exercise of hunting, and often taking his rest amidst the frozen snow. When he came of age, he married his sister named *Laodice*, by whom he had a son named *Pharnaces*. After this he took a journey through many different kingdoms of Asia, having nothing less in view than the whole continent. He learned their different languages, of which he is said to have spoken 22; took an estimate of their strength; and above all viewed narrowly their strong holds and fortified towns. In this journey he spent three years; during which time, a report being spread abroad that he was dead, his wife *Laodice* had a criminal conversation with one of the lords of her court, and had a son by him. When her husband returned, she presented him with a poisoned bowl; but Mithridates had accustomed himself to take poison from his infancy, so that it had now no other effect than to hasten the destruction of his wife, which very soon took place, together with all those who had been any way accessory to her disloyalty and incontinence.

The king now began to put in execution his schemes of conquest. However, he certainly took the wrong method by attacking first those nations which were immediately

Y y 2

Pontus.
10
Conquers
several
countries.

11
Causes the
king of
Cappadocia
to be mur-
dered.

12
Assassinates
his own ne-
phew.

13
Nicomedes
king of Bi-
thynia at-
tempts to
deceive the
Romans.

mediately under the protection of Rome, and thus at once provoking that powerful people to fall upon him. He began with Paphlagonia, which the Romans had declared a free state. This country he easily reduced, and divided between himself and Nicomedes king of Bithynia, at that time his ally. The Romans remonstrated; but Mithridates, instead of paying any regard to their remonstrances, invaded Galatia, which was immediately under their protection. This he also reduced, and then turned his eyes on Cappadocia. But as the kingdom of Cappadocia was at that time held by Ariarathes, who was a great favourite of the Romans, and married to the sister of Mithridates, the latter hired an assassin to dispatch Ariarathes, after which he thought he might succeed better in his designs. After the death of Ariarathes, Cappadocia was invaded by Nicomedes king of Bithynia, who drove out the son, and married the widow of Ariarathes. This gave Mithridates a plausible pretence for invading Cappadocia; which he instantly did, and drove Nicomedes quite out of the country. Thus Mithridates gained considerable reputation, not only as a warrior, but as a just and good-natured prince; for as it was not known that he had any hand in the murder of Ariarathes, every one imagined that he had undertaken the war against Nicomedes, merely to revenge the quarrel of his nephew, and to restore him to his right. To keep up the farce a little longer, Mithridates actually withdrew his troops out of the country, and left the young prince master of the kingdom. In a short time, however, he began to press the young king of Cappadocia to recal the assassin Gordius, who had murdered his father: but this the king of Cappadocia refused with indignation; and Mithridates, being determined on a quarrel at all events, took the field with an army of 80,000 foot, 10,000 horse, and 600 chariots armed with scythes. With this force he imagined he should carry all before him: but finding the king of Cappadocia ready to oppose him with a force no way inferior to his own, he had recourse to treachery; and inviting his nephew to a conference, stabbed him, in the sight of both armies, with a dagger which he had concealed in the plaits of his garment. This barbarous and unexpected piece of treachery had such an effect on the Cappadocians that they threw down their arms, and suffered Mithridates, without opposition, to seize upon all their strong holds. He resigned the kingdom, however, to his son, a child of eight years of age. The care of the young prince, and of the whole kingdom, he committed to Gordius; but the Cappadocians, disdaining to be ruled by such a scandalous assassin, placed on the throne the brother of Ariarathes, who had kept himself concealed in some part of Asia. His reign, however, was of short duration; he being soon after driven out by Mithridates, and the Cappadocians again reduced. The unhappy prince died of grief; and in him ended the family of Pharnaces, who had ruled Cappadocia from the time of Cyrus the Great.

Nicomedes, king of Bithynia, being now greatly afraid of Mithridates, and supposing that his own dominions would next fall a prey to the ambitious conqueror, suborned a youth of a comely and majestic aspect to pretend that he was a third son of Ariarathes, to go to Rome, and demand the kingdom of Cappadocia as his just right. He was received by the senate with the

greatest kindness, and Laodice the wife of Nicomedes even confirmed the deceit by her oath. But in the mean time Mithridates having got intelligence of the plot, sent notice of it by Gordius to the Romans, so that the imposture was soon known at Rome also. The consequence of this was, that the senate commanded Mithridates to relinquish Cappadocia, and Nicomedes that part of Paphlagonia which he possessed; declaring both these countries free. The Cappadocians protested that they could not live without a king; upon which they were allowed to choose one of their own nation. Mithridates used all his interest in favour of Gordius; but he being excluded by the Romans, one Ariobarzanes was chosen by the majority of votes.

To enforce this election, Sylla was sent into Cappadocia. He had the character of an ambassador, but the real intent of his coming was to disappoint the ambitious designs of Mithridates. With a handful of forces he defeated a numerous army of Cappadocians and Armenians commanded by Gordius, and settled Ariobarzanes on the throne. But no sooner was Sylla gone than Mithridates stirred up Tigranes king of Armenia against Ariobarzanes, who, without making any resistance, fled to Rome, and Tigranes restored the kingdom to Ariarathes the son of Mithridates. At the same time died the king of Bithynia; upon which Mithridates immediately invaded that country, and drove out Nicomedes the natural son of the late king. But the expelled prince, having fled to Rome, and being assisted by that powerful republic, the king of Pontus was soon obliged to abandon Bithynia and Cappadocia.

The Romans now being exceedingly jealous of the power and ambition of Mithridates, resolved to humble him at all events. For this purpose they sent ambassadors to the kings of Bithynia and Cappadocia, desiring them to make frequent inroads into the neighbouring territories of Mithridates, and behave there as they pleased; assuring them of powerful assistance in case they should have occasion. Ariobarzanes could not by any means be induced to provoke so powerful a neighbour; but Nicomedes being induced, partly by promises and partly by menaces, to comply, entered Pontus, where he laid waste whole provinces with fire and sword. Mithridates complained to the Roman legates: but they replied, that he himself had been the first aggressor; that Nicomedes had only paid him in his own coin, and that they would not allow him to hurt their friend and ally. Upon this Mithridates, entering Cappadocia with a numerous army, put to flight the united forces of Ariobarzanes and Altinius the Roman legate; thus making himself once more master of this kingdom. In the mean time he sent ambassadors to Rome, complaining of the proceedings of Nicomedes: but his ambassadors met with a very indifferent reception; being enjoined to tell their master, that he must either restore the kingdom of Cappadocia to Ariobarzanes, and make peace with Nicomedes, or be accounted an enemy of the Roman people. With this answer they were commanded to depart the city that very day, and told that no more ambassadors could be admitted till such time as their commands were obeyed.

In the mean time both parties prepared for war. The Roman legates in Asia drew together all the forces they could muster in Bithynia, Cappadocia, Paphlagonia, and Galatia; and, being joined by Cassius governor

Pontus.
14
The deceit
exposed by
Mithrida-
tes.

15
Ariobar-
zanes set-
tled on the
throne of
Cappadocia
by the Ro-
mans, but
driven out
by Mithri-
dates.

16
Who en-
gages in a
war with
the Ro-
mans.

17
Defeats Ariobarzanes and Altinius.

of

Pontus.

of Asia, took the field against Mithridates in the year 89 B. C. They divided their army into several small bodies: Cassius encamped on the confines of Bithynia and Galatia; Manius Aquilius with his body possessed himself of the avenues leading from Pontus into Bithynia; Quintus Oppius secured the entrance into Cappadocia; and the admirals Minucius Rufus and C. Popilius lay with a fleet of 300 sail at Byzantium, to prevent the enemy from entering the Euxine sea. Each of the generals had under his command an army of 40,000 men; besides a body of 50,000 foot and 6000 horse brought to their assistance by Nicomedes.

18
And Nico-
medes and
Manius A-
quilius

On the other hand, Mithridates having invited several of the neighbouring nations to join him, collected an army of 250,000 foot, 50,000 horse, 130 chariots armed with scythes; besides 300 ships and 100 galleys. Part of this force he detached against Nicomedes; and utterly defeated him, though much superior in number, as he was taking possession of an advantageous post by order of Cassius. Another part he detached against Manius Aquilius, whom he also defeated with the loss of 10,000 killed on the spot, and 3000 taken prisoners; on which the other Roman generals abandoned their posts, the fleet also dispersed, and most of the ships were either taken or sunk by the admirals of Mithridates.

19
Over-runs
Asia Mi-
nor.

The king of Pontus now resolving to improve the opportunity, and drive the Romans entirely out of Asia, over-ran all Phrygia, Mysia, Asia Proper, Caria, Lycia, Pamphylia, Paphlagonia, and Bithynia, with all the rest of the countries which had either belonged to or sided with the Romans, as far as Ionia. He was received everywhere with the greatest demonstrations of joy; the inhabitants flocking to him in white garments, and calling him their father, deliverer, their god, and the great and sole lord of all Asia. What gained him the affections of the people was his kind usage to the prisoners he had taken in the two engagements above-mentioned; for he not only sent them all home without ransom, but furnished them with plenty of provisions, and money sufficient to defray their expences by the way. Ambassadors flocked to him from all parts; and among others, from Laodicea on the Lycus, to whom the king promised his protection, provided they delivered up to him Q. Oppius governor of Pamphylia, who had fled thither for protection. This request was readily complied with; Oppius was sent to him in chains, with lictors walking before him in derision of the Roman pride and ostentation. Mithridates was overjoyed to see a Roman general and proconsul in his power; and his joy was soon after increased by the arrival of Manius Aquilius, whom the Lesbians, revolting from the Romans, sent to him in fetters, together with many other Romans of distinction who had taken shelter among them. As he had been the chief author of the war, Mithridates led him about with him wherever he went, either bound on an ass, or on foot coupled with one Baitarnes a public malefactor, compelling him to proclaim to the crowds who came to see him, that he was Manius Aquilius the Roman legate. When he came to Pergamus, he caused him first to be publicly whipped, then to be put on the rack, and lastly melted gold to be poured down his throat.

20
Puts Aquili-
us to
death.

Mithridates being now looked upon as invincible, all the free cities of Asia received him as their sovereign,

contributing large sums towards the defraying the expences of the war; by which means he became possessed of such treasures as enabled him to keep several numerous armies in the field for five years without levying any taxes on his subjects. As many Roman citizens were dispersed in the provinces which Mithridates had subdued, he considered these as so many spies who would not fail to send an account of his proceedings to Rome: for which reason he resolved to cut them all off at once by a general massacre; which barbarous policy, it is said, had never been heard of till his time, but has been since practised by other nations. He dispatched private

Pontus.

21
Cruelly
massacres
all the Ro-
mans in
Asia.

letters to all the governors and magistrates of the cities where the Romans resided, enjoining them on pain of death, and the entire destruction of their country, to cause all the Italian race, women and children not excepted, to be murdered on the 30th day from the date of his letters, and to let their bodies lie unburied in the open fields. One moiety of their goods was to be forfeited to the king, and the other bestowed as a reward on the assassins. Whatever slave murdered his master was to receive his liberty, and one half of the debt was to be remitted to the debtor that should kill his creditor. Whoever concealed an Italian, under any pretence whatever, was to be punished with immediate death. On the fatal day, all the gates of the cities being shut, and the avenues kept with soldiers, the king's orders were proclaimed, which caused an universal horror, not only among the unhappy victims themselves, but among those who had any feelings of humanity, at seeing themselves obliged either to betray and murder their innocent guests, friends, and relations, or to become liable to a cruel death. However, as most of the Asiatics bore a mortal hatred to the Romans, and were more-over animated by the promise of an ample reward, the orders were without delay put in execution. The inhabitants of Ephesus, where Mithridates then resided, dragged such as had taken sanctuary in the temple of Diana from the very statue of the goddess, and put them to the sword. The Pergamenians discharged showers of darts upon them as they embraced the statues in the temple of Esculapius. At Adramyttium in Mysia many were murdered in the water, while they were attempting, with their children on their backs, to swim over to the island of Lesbos. The Caunians, who not long before had been delivered from the yoke of the Rhodians, and restored to their ancient privileges, excelled all the rest in cruelty: for, as if they had apostatized from human nature, they took pleasure in tormenting and butchering the innocent children before their mothers eyes; some of them running distracted, and others dying with grief at a sight which nature could not bear. The Trallians were the only people on the continent who would not have the cruelty to imbrue their hands in the blood of the innocent Italians. However, as the king's orders were peremptory, they hired one Theophilus a Paphlagonian to dispatch the few Romans that lived among them. He, having shut them all up together in the temple of Concord, first cut off their hands as they embraced the statues of the gods, and then hacked them in pieces. Many Romans were saved on the floating islands of Lydia called *Calamina*, where they concealed themselves till such time as they found an opportunity of escaping out of Asia. Never-
theless.

Pontus. theless, according to Plutarch and Dion, 150,000 Roman citizens were massacred on that day; but, according to others, only 80,000.

22
Reduces
the island
of Cos,

Mithridates having now got rid of those whom he was in dread of on the continent, embarked great part of his forces in order to reduce the islands of the Archipelago. At Cos he was gladly received, and had delivered up to him the young Alexander, son of Alexander king of Egypt, who being driven out of that country, was killed by Chareas a sea-captain as he was retiring in a small vessel to Cyprus. With the young prince, they put into the king's hands vast sums of money, with all the golden vessels and jewels, to an immense value, which his grandmother Cleopatra had been amassing for many years. To the young prince Mithridates gave an education suitable for a king's son, but kept the treasures to himself. Here likewise he found 800 talents in ready money, which, at the first breaking out of the war, had been deposited by the Jews of Asia, and were designed for the temple of Jerusalem.

23
But fails in
his at-
tempt upon
Rhodes.

From Cos Mithridates steered his course for Rhodes, where at that time all the Romans who had escaped the massacre above-mentioned found a sanctuary, and, amongst others, L. Cassius the proconsul. The Rhodians, however, being very expert in maritime affairs, Mithridates did not think proper to venture an engagement. As the enemy's fleet advanced, therefore, he retired; but six of the Rhodian ships coming up with 25 of his, a sharp action ensued, in which the Rhodians sunk two of the king's ships, and put the rest to flight. In this encounter, though Mithridates had never seen a sea-fight before, he behaved with great intrepidity; but one of the ships of his own squadron falling foul of that which carried him, he was very near being taken prisoner. From this time forth he abhorred the sea, and took an aversion to all the Chians, because the pilot of that ship was a Chian. However, he again appeared before the island; but was forced anew to leave it with disgrace, and to give over all thoughts of reducing it.

24
His gene-
rals reduce
all Greece.

Mithridates now retired into Asia, with a design to settle the civil government of the countries which he had conquered, committing the care of the war to his generals. Archelaus, his generalissimo, was sent into Greece with an army of 120,000 men; where, by treachery, he made himself master of Athens, and either put to the sword or sent to Mithridates all those who favoured or were suspected to favour the Romans. From Athens he dispatched parties to reduce the neighbouring castles and the island of Delos, which they did accordingly; but Orobias, a Roman general, hearing that the enemy kept no guards, but passed their time in carousing and debauchery, fell upon them unexpectedly, and cut off the whole party, except Apellicon the commander.

In the mean time, Metrophanes, another of the king's generals, entering Eubœa, laid waste the whole country, exerting his rage chiefly against the cities of Demetrias and Magnesia, which refused to open their gates to him. But as he was sailing off with a great booty, Bryttius, the prætor or governor of Macedonia, coming up with him, sunk some of his ships, and took others, putting all the prisoners to the sword. Mithridates, upon the news of this loss, sent his son Ariarathes with a powerful army to invade Macedonia; which he soon reduced, to

gether with the kingdom of Thrace, driving the Romans everywhere before him. The generals whom he sent into other quarters were no less successful; so that Mithridates had, according to Aulus Gellius, 25 different nations who paid him homage. The same author adds, that he was skilled in every one of their various languages, so that he could converse with the natives without an interpreter. Amongst these nations we find the Rhoxani, now the Russians or Muscovites, whom Deiphontus, one of the king's generals, brought under subjection, after having slain in an engagement 50,000 of the barbarians.

All this time the Romans had been too much taken up with their own domestic quarrels to take such effectual measures as they otherwise would have done for checking the progress of Mithridates. But at last, having received certain advice that the king designed to invade Italy, and that he had even been solicited to do so by some of the revolted Italians, they sent against him Lucius Sylla, who had already given sufficient proofs of his courage, conduct, and experience in war. He had with him only five legions and a few cohorts. With this inconsiderable force he landed in Attica, and in a short time made himself master of the capital; Archelaus not daring, or, according to others, through treachery, not caring, to engage him. As Sylla had but a few frigates, he sent Lucullus to the island of Rhodes, with orders to the Rhodians to join him with their fleet. The undertaking was very dangerous, as the king's fleet in a manner covered the sea. However, Lucullus, despising all danger, ventured out, and sailed, without meeting with any perverse accident, to Syria, Egypt, Libya, and Cyprus; from whence he returned with such supplies of ships and experienced mariners, as enabled Sylla, after their conjunction with the Rhodians, to act offensively by sea also. Archelaus now dispatched messengers to Taxiles, who commanded in Thrace and Macedon, desiring him to join him with all his forces; which the other readily did, and between both mustered an army of 120,000 men. Sylla met them near Cheronæa with only 15,000 foot and 1500 horse; but gave them a most dreadful overthrow, no fewer than 110,000 of the Asiatics being slaughtered, while the Romans lost only 12 men.

This success having raised envy and jealousy against Sylla in Rome, the senate sent Lucius Valerius Flaccus, the consul of that year, with two legions into Asia, in appearance to attack Mithridates on that side, but with private instructions to fall upon Sylla himself, if they found him disaffected to the senate. As Flaccus was a man of no experience in war, C. Fimbria, a senator of great repute among the soldiery, was appointed to attend him with the character of legate and lieutenant-general. Sylla was at that time in Bœotia; but, hearing what had happened at Rome, he marched with all expedition into Thessaly, with a design to meet Flaccus, who, he expected, was to land in that province. But no sooner had he left Bœotia, than the country was over-run by an army of Asiatics, under the command of Dorylaeus the king's chief favourite. On this advice Sylla returned into Bœotia, where he gained two signal victories, which put an end to the war in Greece. In the first of these Dorylaeus lost 150,000 of his men according to some, or 200,000 according to others; and in the next all the rest. In this last engagement Sylla gained two other victories in Greece.

Pontus.

Pontus.

20,000 were driven into a river, where they all perished; an equal number were pursued into a marsh, and entirely cut off; the rest were killed in the heat of battle, the Romans giving no quarter to men who had treated their fellow-citizens after such a barbarous manner in Asia. Plutarch tells us, that the marshes were dyed with blood; that the course of the river was stopped by the dead bodies; and that even in his time, that is, near 200 years after, a great number of bows, helmets, coats of mail, and swords, were found buried in the mud. Archelaus, who had joined Dorylaus with a body of 10,000 men a few days before the battle, lay three days stripped among the slain till he found a small vessel which carried him to Eubœa, where he gathered what forces he could, but was never again able to appear in the field. Indeed Livy tells us, that Archelaus betrayed the king's cause; and Aurelius Victor, that the king's fleet was intercepted by Sylla through the treachery of Archelaus: adding, that there was a good understanding between the two commanders, as was plain from Sylla's bestowing upon Archelaus 10,000 acres of land near the city of Chalcis in Eubœa. Strabo also informs us, that Archelaus was afterwards greatly esteemed and caressed by Sylla and the senate; but Sylla himself in his commentaries, and Dio, endeavour to clear Archelaus from all suspicion of treachery.

29
Fimbria
puts Flac-
cus to
death.

In the mean time, Sylla having given up Bœotia to be plundered by his soldiers, marched into Thessaly, where he took up his winter-quarters, caused his old ships to be refitted and several new ones built, in order to pass over into Asia in the beginning of the spring, that he might drive from thence not only Mithridates, but his rival Flaccus also, whom the senate, out of opposition to him, had appointed governor of that province. But before he arrived, some differences having arisen between Flaccus and Fimbria, the latter was by the consul deprived of his command. Upon this Fimbria, having gained over the soldiery to his side, made war on the consul, took him prisoner, put him to death, and assumed the command of all the Roman forces in Asia. In this station he behaved with the greatest cruelty, insomuch that his name became more odious than even that of Mithridates itself. This hatred the king of Pontus endeavoured to improve to his own advantage; and therefore commanded his son, by name also *Mithridates*, to join Taxiles, Diophantes, and Menander, three of his most experienced commanders, to return at the head of a numerous army into Asia; not doubting but the inhabitants, thus harassed by Fimbria, would shake off the Roman yoke when they saw such a powerful army in the field ready to protect them. But Fimbria, distrusting the Asiatics, marched out to meet the enemy, and offered them battle before they entered the province. As the king's army was greatly superior to the Romans in number, the latter suffered greatly in the engagement, but held out till night parted them, when they withdrew to the opposite side of a river, which was at a small distance from the field of battle. Here they designed to intrench themselves: but in the mean time a violent storm arising, Fimbria laid hold of that opportunity to repass the river and surprise the enemy: of whom he made such havoc as they lay in their tents, that only the commanders and some few troops of horse escaped. Among these was the king's son; who, attended by a few horse, got safe

30
Defeats the
forces of
Mithrida-
tes,

31
And be-
sieges the
king;

to Pergamus, where his father resided. But Fimbria, pursuing him night and day without intermission, entered Pergamus sword in hand; and hearing that both Mithridates and his son had fled from thence a few hours before, he continued his pursuit, and would have taken the king himself, had he not entered Pitane with a considerable body of horse. The place was closely invested by Fimbria; but as he had no ships to block it up by sea also, he sent a messenger to Lucullus, who commanded the Roman navy in Asia, intreating him, as he tendered the welfare of the republic, to make what haste he could to Pitane, and assist him in taking the most inveterate enemy the Romans had. But Lucullus, preferring the gratification of a private pique to the good of his country, refused to come: and thus allowed the fleet of Mithridates to carry him in safety to Mitylene.

32
Who is suf-
fered by
Lucullus
to escape.

Soon after the king's departure, Fimbria took Pitane by storm, and reduced most of the cities of Asia, particularly Troy, which he also took by storm in eleven days, and put most of the inhabitants to the sword, because they had sent an embassy to Sylla, offering to submit to him rather than to Fimbria.—To add to the misfortunes of Mithridates, his fleet was entirely defeated in two engagements by Lucullus; so that he began to be weary of the war, and therefore desired Archelaus to conclude a peace upon as honourable terms as he could. The king himself had afterwards also a conference with Sylla, and a peace was concluded in 85 B. C. on the following terms, viz. That Mithridates should relinquish all his conquests, and content himself with his paternal dominions, which were confined within the limits of Pontus: that he should immediately resign Bithynia to Nicomedes, and Cappadocia to Ariobarzanes, and release without ransom all the prisoners he had taken during the war: that he should pay to the Romans 2000, or as others will have it 3000, talents, and deliver up to Sylla 80 ships with all their arms and ammunition, and 500 archers; and lastly, that he should not molest such cities or persons as had during the war revolted from him and sided with the Romans.

33
A Peace con-
cluded.

Sylla, having thus concluded the war with great glory to himself and advantage to the republic, turned his army against Fimbria; but the latter, finding himself in no condition to oppose his rival by force, had recourse to treachery, and attempted to get Sylla murdered. The plot miscarried, and Fimbria put an end to his own life; upon which Sylla, having now an uncontrolled power in Asia, declared the Chians, Rhodians, Lycians, Magnesians, and Trojans, free, and friends of the people of Rome, by way of reward for their having sided with the Romans: but on the other cities he laid heavy fines; condemning them in one year to pay 20,000 talents, and quartering his soldiers in the houses of those who had shown disaffection to the Romans. Each private man was to receive of his landlord 16 drachmas a-day, and each officer 50; and besides, both were to be supplied with provisions, not only for themselves, but for such of their friends as they thought proper to invite. By these impositions most of the people of Asia were reduced to beggary; especially the inhabitants of Ephesus, who had above all others shown their hatred to the Romans. Sylla then, having collected immense treasure, set sail for Italy; leaving behind him Lucullus with

Pontus.

with the character of *questor*, and Muræna with that of *praetor*.

The two legions which Fimbria had commanded were given to Muræna, because Sylla suspected them of an inclination to the faction of Marius, whose party he was going to crush at Rome.

34
Mithridates reduces the nations which had revolted from him.

Mithridates in the mean time no sooner returned into Pontus, than he set about the reduction of those nations which had revolted from him during the war. He began with the Colchi; who immediately submitted, upon condition that Mithridates would give his son for a king over them. This was complied with; but the old king had thenceforward a jealousy of his son, and therefore first imprisoned and then put him to death. Soon after this, the king having made great preparations under pretence of reducing the Bosphori, a warlike nation who had revolted from him, the Romans began to be jealous. Their jealousy was further increased by Archelaus, who fled to them, and assured them that the preparations of Mithridates were not at all designed against the Bosphori. On hearing this, Muræna invaded Pontus without any farther provocation. The king put him in mind of the articles of peace concluded with Sylla; but Muræna replied that he knew of no such articles; for Sylla had set nothing down in writing, but contented himself with the execution of what had been agreed upon. Having given this answer, the Roman general began to lay waste and plunder the country, without sparing even the treasures or temples consecrated to the gods. Having put all to fire and sword on the frontiers of Pontus towards Cappadocia, he passed the river Halys, and on that side possessed himself of 400 villages without opposition; for Mithridates was unwilling to commit any hostilities before the return of an ambassador whom he had sent to Rome to complain of the conduct of Muræna. At last the ambassador returned, and with him one Callidius; who, in public assembly, commanded Muræna to forbear molesting a friend and ally of the Roman people; but afterwards, calling him aside, he had a private conference with him, in which it is supposed, as he brought no decree of the senate, that he encouraged him to pursue the war. Whatever might be in this, it is certain that Muræna still continued to practise the same hostilities, and even made an attempt on Sinope, where the king resided and the royal treasures were kept. But as the town was well fortified, he was forced to retire with some loss.

35
The Romans invade his territories without provocation,

36
But are defeated.

In the mean time Mithridates himself taking the field, appeared at the head of a powerful army, drove the Romans out of their camp, and forced them with great slaughter to save themselves over the mountains into Phrygia; which sudden victory again induced many cities to join Mithridates, and gave him an opportunity once more of driving the Romans out of Cappadocia.

In the mean time, Sylla, being created dictator at Rome, sent a messenger to Muræna, charging him in his name not to molest Mithridates, whom he had honoured with the title of a friend and ally of Rome. Muræna did not think proper to disregard this message; and therefore immediately abandoned all the places he had seized, and Mithridates again renounced Cappadocia, giving his own son as an hostage of his fidelity. Being then at leisure to pursue his other plans, Mithridates fell upon the Bosphori; and, having soon subdued them, appointed Machares one of his sons king of the

country. But leading his army from thence against the Achæans, a people bordering on the Colchi, and originally descended from the Greeks, who returning from Troy had mistaken their way into Greece and settled there, he was defeated with the loss of three-fourths of his men. On his return to Pontus, however, he recruited his army, and made vast preparations to invade them anew; but in the mean time, hearing of Sylla's death, he came to the imprudent resolution of entering into a second war with the Romans. Having therefore induced his son-in-law Tigranes, king of Armenia, to invade Cappadocia, he himself entered Paphlagonia at the head of 120,000 foot disciplined after the Roman manner, 16,000 horse, and 100 chariots armed with scythes. This country readily submitted; after which the king marched into Bithynia, which also submitted without opposition; the province of Asia followed the example of the rest; for these countries being oppressed with exorbitant taxes, looked upon him as their deliverer. In entering the cities of Asia, he caused M. Marius or Varius, whom Sertorius had sent him out of Spain to discipline his troops, walk before him with the ensigns of consular dignity as if he was the chief magistrate; the king following as one of his attendants. He made several cities free; but at the same time acquainted the inhabitants, that they were indebted to Sertorius for their liberty; and thus, by the connivance of that general, many cities revolted from the Romans without knowing that they had done so. But in the mean time Julius Cæsar, being at that time at Rhodes, whither he had gone to study oratory, and hearing what havoc the king's officers made in the adjacent countries, he collected what troops he could, and falling unexpectedly upon them, drove them quite out of the province of Asia.

Pontus.

37
Engages in a new war with the Romans.

The Roman senate, now finding a war unavoidable, appointed Lucullus to manage it. The other consul Cotta, having solicited an employment in this war, was sent with a fleet to guard the Propontis and defend Bithynia. Lucullus having raised one legion in Italy, passed over with it into Asia, where he was joined by four others, two of which, as they had served under Fimbria, proved at first very mutinous and refractory; nor were the other two much better, having been immersed in the Asiatic luxuries. The disciplining of these troops took up a considerable time, which was prejudicial to the Roman affairs; for almost all the Asiatics were ready to revolt, and Mithridates was making the greatest preparations. One of his armies was ordered to march into Cappadocia, under the command of Diophantus Matharus, in order to oppose Lucullus if he should attempt to enter Pontus on that side; another, commanded by Mithridates in person, consisted of 150,000 foot, 12,000 horse, and 100 chariots armed with scythes; a third army, commanded by Marius and Eumachus, two generals of great experience in war, was encamped in the neighbourhood of Heraclea in Pontus.

38
Lucullus and Cotta sent against him.

The beginning of the war proved favourable to Mithridates. Cotta being desired by Lucullus to keep his fleet within the harbour, as being inferior to that of Mithridates, resolved to take the first opportunity of fighting the king by land, not doubting of an easy victory. Having for this purpose collected all the forces he could, Cotta dispatched his legate, P. Rutilius, with

39
Mithridates is at first successful,

Pontus.

a considerable body to observe the motions of the enemy. This commander being met by Marius and Eumachus, an engagement ensued, in which the Romans were defeated, and the greatest part of them, together with their commander, cut in pieces. The same misfortune befel several other officers of distinction sent out to oppose Mithridates; who, being elated with success, ordered his admiral to sail into the very harbour, and fire the Roman fleet. This was accordingly performed without the least opposition from Cotta; and 60 ships were taken, sunk, or burnt, on that occasion.

These victories having increased the rebellious disposition of the Asiatics, made Lucullus hasten his march in order to stop the progress of the enemy. But finding the king's army much more numerous than he expected, he thought proper to decline an engagement. However, several skirmishes happened, in which the Romans had always so much the advantage, that they became impatient for a general engagement. But Lucullus did not at this time choose to run so great a risk; and therefore Mithridates, seeing he could not force the Romans to a battle, decamped in the night-time, and by day-break reached Cyzicum, a most important city, and greatly attached to the Romans. Lucullus pursued him; and, falling on his rear, killed 10,000, and took 13,000 prisoners. After this, the Roman general, by a manœuvre, gained an important pass, which enabled him to cut off all communication between the army of Mithridates and the neighbouring country. The king, seeing himself thus in danger of famine, redoubled his efforts to gain the city; but finding that he could not batter down the walls, he resolved to undermine them. In this also he was unsuccessful; the besieged sunk countermines, and had very near taken the king himself in one of his own mines. In the mean time, winter coming on, the army of Mithridates was so distressed for want of provisions, that many died of hunger, while the survivors were forced to feed on the flesh of their dead companions. The famine was followed by a plague; which destroyed such numbers, that Mithridates was obliged to think of a retreat; and even this was become very dangerous. However, he laid hold of the opportunity when Lucullus went away to besiege a neighbouring castle, and sent off the greatest part of his cavalry in the night; ordering them not to halt till they were out of the reach of the enemy. But Lucullus having got intelligence of their march, suddenly returned, and pursued them so close, that he came up with them as they were passing a river, took 600 horse, all their beasts of burden, 15,000 men, and put the rest to the sword. On his return he fell in with Aristonicus the king's admiral, whom he took, just as he was ready to sail with a large sum of money designed to bribe the Roman army. In the mean time Mithridates, finding himself reduced to the last extremity, embarked in the night-time with the greatest part of the forces, while Marius and Eumachus, with 30,000 men, made the best of their way to Lampascus. But being closely pursued by the Romans, they were overtaken at the river Æsopus, which at that time was not fordable, by reason of its having been swelled by heavy rains. Twenty thousand were killed on the spot; nor could a single man have escaped, had not the Asiatics scattered great quantities of gold and silver in

Vol. XV. Part I.

the way, that the march of the Romans might be retarded by their stopping to gather it up. Lucullus on his return entered Cyzicum amidst the acclamations of the citizens; who afterwards instituted public sports in honour of him, which they called *Luculleæ*. The city was declared free, and all the privileges, exemptions, and immunities, bestowed upon the citizens which were enjoyed by the inhabitants of Rome itself.

From Cyzicum, Lucullus marched along the coast of the Hellespont till he came to Troas; where he equipped his fleet, and put to sea in quest of Marius, Alexander, and Dionysius, three of the king's generals, who had a fleet of 50 ships, with 10,000 land-forces on board. Lucullus came up with them near the island of Lemnos, took 32 of their ships, and put a great number of their land-forces to the sword. The day after the engagement the three generals were discovered in a cave where they had concealed themselves, and dragged from thence to Lucullus; who, after having severely upbraided Marius for fighting against his country, caused him to be put to death. Alexander and Dionysius were reserved for the triumph; but the latter poisoned himself to avoid that disgrace. Lucullus then steered his course for Bithynia, on receiving intelligence that Mithridates had appeared with his fleet on those coasts: but the king having notice of his approach, made what haste he could to gain Pontus, and arrived at Heraclea on board a pirate named *Selemus*; with whom he was obliged to trust himself, his fleet being dispersed by a violent storm, and the ship that carried him cast away.

In the mean time Mithridates was no less unfortunate by land than by sea. Triarius, one of the officers of Lucullus, reduced the cities of Apamea, Prusa, Prusias, and Nicæa. From thence he marched with all expedition to Nicomedia, where the king himself was, and near which place Cotta lay encamped. But before the two armies could be joined, Mithridates escaped, first to Heraclea, which was betrayed to him, and from thence to Sinope. Nor was Lucullus himself all this time inactive. Having reduced all Paphlagonia and Bithynia, he marched through Cappadocia, and joined Cotta and Triarius at Nicomedia, with a design to invade Pontus; but hearing that Heraclea was in the hands of Mithridates, he dispatched Cotta to reduce that city. Triarius was ordered with the fleet to the Hellespont and Propontis, to intercept the king's fleet, which was daily expected from Spain with supplies from Sertorius. Lucullus himself, with the main strength of the army, pursued his march into Pontus. His army was greatly harassed, especially in the narrow passes between Cappadocia and Pontus, by flying parties of the enemy. But the greatest inconvenience was the want of provisions, as the king's troops had laid waste all the country round; insomuch that Lucullus having lost almost all his beasts of burden, was obliged to take along with the army 30,000 Galatians, each of them carrying a sack of corn on his back. At last, however, he gained the plains of Pontus; where provisions were so plentiful, that an ox was sold for a drachma, and every thing else in proportion.

The Roman general having now carried the war into the enemy's country, divided his forces, and at the same time invested a very strong town named *Amisus*; another called *Eupatoria*, built by Mithridates, and made

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the

40
But is reduced to great straits by Lucullus,

41
Who cuts off great numbers of his men.

42
Lucullus gains a great victory at sea.

43
Far her successes of Lucullus.

Pontus.

the place of his residence; and another, named *Themiscyra*, situated on the banks of the *Thernodoon*. *Eupatoria* was soon taken, but *Themiscyra* made a vigorous resistance. The townsmen galled the Romans to such a degree, that, not daring to approach the walls openly, they contented themselves with undermining them: but in this too they met with no small difficulty; for the enemy countermined, and often engaged them, under ground, letting into the mines bears and other wild beasts, with swarms of bees, which obliged them to abandon their works. However, the town was at last obliged to surrender for want of provisions. As for *Amifus*, *Lucullus* himself sat down before it: but finding it strongly fortified and garrisoned with the flower of the king's troops, the Roman general thought proper to reduce it by famine; and on this occasion his countrymen first complained of him as protracting the war for his own advantage.

In the mean time *Mithridates* having recruited his shattered army, advanced to *Cabiræ*, a city not far distant from *Amifus*. *Lucullus*, leaving part of the army to continue the siege, marched at the head of the rest to oppose *Mithridates*. But the king having drawn his cavalry into a general engagement, defeated them with considerable loss, and drove them back to the mountains, through the passes of which *Lucullus* had lately marched to attack him. This check obliged the Roman general to retire to a rising ground near the city of *Cabiræ*, where the enemy could not force him to an engagement. Here provisions beginning to grow scarce, *Lucullus* sent out strong parties from his army into *Capadocia*, the only place from whence he could have supplies. One of these parties entirely defeated *Taxiles* and *Diophantes*, two of the king's generals, who had been stationed there to prevent *Lucullus* from having any communication with the country. The king, upon the news of this defeat, resolved to break up his camp and retire, not questioning but that *Lucullus* would attack him as soon as his forces returned. This resolution he no sooner imparted to his nobles, than they began privately to send away their most valuable goods; which being found out by the soldiers, they took it in such bad part that no intelligence had been given them, that they plundered their baggage, and put those who had the care of it to the sword. After this they betook themselves to flight, crowding out of the gates in the utmost confusion. The king hastened to stop their flight; but nobody showing him the least respect, he was carried away by the crowd, and in great danger of being trampled to death. Having with difficulty made his escape, he retired with a small retinue, first to *Cabiræ*, and then to his son-in-law *Tigranes* king of *Armenia*. *Lucullus* dispatched the best part of his cavalry to pursue the fugitives; while he himself, with the rest, invested the camp of *Mithridates*, where those remained who could not fly with the rest. The camp was easily taken; but most of the soldiers made their escape, while the Romans, contrary to their general's orders, were busied in plundering. *Lucullus* then pursued hard after the king; who, being overtaken by a company of *Galatians*, caused a mule loaded with part of his treasures to be driven in among them, by which means he made his escape while they quarrelled about the booty. *Mithridates*, remembering in his flight, that he had left his sisters, wives, and concubines

at *Pharnacia*, dispatched an eunuch, named *Bacchus* or *Bacchides*, with orders to put them all to death, lest they should fall into the hands of the enemy; which was accordingly done.

After the flight of *Mithridates*, the Romans no longer met with any opposition; the king's governors flocking from all parts to put themselves under the protection of the conqueror. Among these was the grandfather of *Strabo* the geographer, whom the king had disoblged by putting to death his cousin-german *Tibias*, and his son *Theophilus*. He was a man of such credit, that it was no sooner heard that he had abandoned the king's party, than 15 other commanders delivered up to *Lucullus* the places with which they had been intrusted; and about the same time *Triarius* falling in with the king's fleet near the island of *Tenedos*, obtained a complete victory, having either taken or sunk 60 of the enemy's vessels.

All this time *Cotta* had been employed without success in besieging *Heraclea*, which he could never have reduced without the assistance of *Triarius*. That commander, having defeated the fleet, soon reduced the town to such distress, that a third part of the garrison died of hunger; upon which the governor, *Conacorex*, privately agreed with *Triarius* to deliver one of the gates to him. This was accordingly done; and the Romans, entering, made a terrible slaughter of the helpless inhabitants. But in the mean time *Cotta*, provoked at seeing himself deprived both of all share of the booty, and the honour of reducing a place before which he had sat so long, fell upon his countrymen as they were busied in plundering; which would have occasioned a great deal of bloodshed, had not *Triarius* promised to divide the booty equally. *Conacorex*, in order to conceal his treachery, after marching out of *Heraclea*, seized on two forts belonging to the Romans; and *Triarius* being sent to recover them, *Cotta*, in his absence, plundered the city anew, rifled the temples which the other had spared, put all the citizens he could meet with to the sword, and having carried off every thing valuable, at last set fire to the city in several places, by which means it was soon reduced to ashes. *Cotta* then, having no farther occasion for his troops, dismissed the auxiliaries, resigned his legions to *Lucullus*, and put to sea himself in order to return to *Rome*. But he had scarce got out of the harbour, when part of his ships, being overloaded with the spoils of the city, sunk; and the others were by a violent north wind dashed against the shore, which occasioned the loss of a great part of the booty. However, on his return to *Rome*, he was highly applauded by the senate, and honoured with the title of *Ponticus*.

Lucullus, having now reduced *Pontus*, marched against the *Chaldeans*, *Tibarenians*, and inhabitants of *Armenia Minor*; who voluntarily submitted to him, and put him in possession of all their strong holds. From *Armenia*, he returned before *Amifus*, which still held out; *Callimachus*, governor of the place, having harassed the Romans to such a degree by engines of his own contriving, that they had given over their assaults, and contented themselves with blocking it up by land, though the garrison was at the same time plentifully supplied with provisions by sea. *Lucullus*, on his arrival, summoned the city to surrender, offering

Pontus.

44
The army of *Mithridates*, mutinied, which obliges the king to fly into *Armenia*.

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Pontus.

ing the inhabitants very honourable terms; but, being refused, he made a general assault at the time when he knew that Callimachus used to draw off great part of his troops to give them some respite. The Romans applying their scaling ladders, got over the wall before Callimachus could come to the assistance of those whom he had left to guard it; however, by setting the city on fire, he found means in that confusion to make his escape. Lucullus commanded his men to use their utmost endeavours to save the city; but they being intent only upon plundering, regarded nothing but the furniture. At last the fire was extinguished by a violent shower; and Lucullus, having with much ado restrained his soldiers from committing any farther excesses, repaired the city in some measure before he left it, and suffered the inhabitants to enjoy their possessions in peace.

45
Tigranes
defeated by
Lucullus,

Nothing was now wanting but the captivity of Mithridates himself to put a final period to the war; and therefore Lucullus demanded him from his son-in-law, Tigranes. But though that prince could not be prevailed to see Mithridates on account of his misconduct, he could as little be induced to deliver him up to his enemies. After this refusal, however, he for the first time condescended to see his father-in-law, after he had resided a year and eight months in his dominions. In a private conference held by the two kings, it was agreed, that Tigranes should march against the Romans, and Mithridates with 10,000 horse return into Pontus, where he should make what levies he could, and rejoin Tigranes, before Lucullus, who was then employed in the siege of Sinope, could enter Armenia. But, in the mean time, Sinope having surrendered, Lucullus with all possible expedition marched against Tigranes, and, having drawn him into a general engagement, gave him an entire defeat, as is related under the article ARMENIA.

46
But resolves
to try another
campaign.

Mithridates was marching to his assistance, when he met his son-in-law flying with a small retinue to shelter himself in some remote corner of the kingdom. He encouraged him to raise new forces; not doubting but that another campaign would repair all former losses, provided he would commit to his management every thing relating to the war. To this Tigranes agreeing, as he thought him more fit to deal with the Romans than himself, orders were issued out for raising a new army, and all the Armenians able to bear arms summoned to meet at the place of the general rendezvous. Out of these Mithridates chose 70,000 foot and 35,000 horse; and having trained them up during the winter, after the Roman discipline, in the beginning of the spring he left part of them with Tigranes, and marched himself with the rest into Pontus, where he recovered many important places, and overcame in a pitched battle M. Fabius, whom Lucullus had appointed governor of that province. Being flushed with this success, as soon as the wounds he received in the engagement suffered him to move, he pursued Fabius, and besieged him in the city of Cabira, whither he had retired; but in the mean time Triarius, who was marching out of Asia to join Lucullus, hearing what distress the Romans were in, hastened to their relief, and appearing unexpectedly on the neighbouring hill, struck such terror into the enemy, that they raised the siege, and made the best of their way into Cappadocia. Tri-

Pontus.

arius pursued them, and got so near them as to be parted only by a river. Here he halted, with a design to pass the river after he had allowed his men some rest; for they were tired out with long marches. But Mithridates was before-hand with him, and crossing the river on a bridge, where he had placed a strong guard, attacked the Romans with great resolution before they had time to refresh themselves. The battle was bloody, and the event doubtful, till the bridge breaking down with the weight of the multitude that passed, the king's troops who had engaged, relying chiefly on their numbers, began to lose courage, seeing they could receive no further assistance; and the Romans charging them with fresh vigour, they betook themselves to a precipitate flight. After this engagement, as winter came on, both armies were glad to retire to their winter-quarters.

47
Mithridates
defeated.

During the winter, Mithridates raised new forces; and having received considerable supplies from Tigranes, took the field early in the spring, in hopes of driving the Romans quite out of Pontus, before Lucullus, who had work enough on his hands in Armenia, could come to their assistance. With this view he marched straight against Triarius and Sornatius, to whom Lucullus had committed the care and defence of that province; and finding them encamped near the city of Gaziumsa, proffered them battle; which they declining, he sent a strong detachment to besiege a castle where the Romans had left all their baggage, hoping they would rather venture an engagement to relieve the place, than lose all they had got with so much toil and labour during the war: neither was he disappointed in his hopes; for though Triarius was for keeping close in his camp till the arrival of Lucullus, whom he daily expected, having acquainted him with the danger, the soldiers hearing that the castle was besieged, declared in a tumultuous manner, that if he did not lead them they would march to the relief of the place without his leave. Triarius being thus forced by his own men to fight, drew out his forces against the king, whose army was three times his number; but while they were upon the point of engaging, both armies were by a violent storm forced to retire to their respective camps; but Triarius receiving that very day intelligence of the approach of Lucullus, and fearing he would snatch the victory out of his hands, resolved to make a bold push, and next morning by break of day attack the king in his camp. If he conquered, the glory he thought would be entirely his own; if he were overcome, the enemy could reap no great advantage from his victory, Lucullus being at hand with a powerful army. The king, in that surprise, putting himself at the head of a few troops of his guards, sustained the brunt of the Romans, till the rest of his army drawing up came to his relief, and attacked the enemy with such fury, that the Roman foot were forced to give way, and were driven into a morass, where they were surrounded, and great numbers of them cut in pieces.

48
Defeats
Triarius.

Their horse were likewise put to flight, and pursued with great slaughter, till a Roman centurion in the king's service, pitying his countrymen, attempted to kill him. The king's life was saved by his breastplate; but as he received a deep wound in the thigh, he was obliged to give over the pursuit himself, and those that were about him caused the retreat to be

Pontus.

founded, which, as it was unexpected, occasioned a great confusion in the whole army. The centurion was immediately cut in pieces; but the Roman horse in the mean time getting the start of the enemy, found means to make their escape. Above 7000 of the Romans were killed in that battle; and among them 150 centurions and 24 tribunes, the greatest number of officers that had been lost in any engagement to that day. Mithridates being cured of his wound, that he might not for the future be exposed to such dangers, caused all the Romans that served in his army to be formed into one body, as if they were to be sent out on a party, and then ordered them to retire to their tents, where they were all to a man cut in pieces.

49
All the Romans in the service of Mithridates massacred.

The king, however elated with success, yet would not engage Lucullus; but with long marches hastened into Armenia Minor, and encamped upon a hill near the town of Talura, expecting Tigranes, who was advancing with a strong army to join him. Lucullus, in pursuit of Mithridates, marched over the field of battle, leaving those unburied who had fallen in the engagement, which alienated the minds of the soldiery from him, and they began to be very mutinous; being stirred up by Appius Claudius, whom Lucullus had turned out of his command for his vile behaviour, notwithstanding he was nearly related to him, Lucullus having married his sister. The discontent that prevailed in the army came to such a height, that Lucullus was obliged to lie still in his camp all that summer; the soldiers declaring in a mutinous manner, that they would not follow him any longer, nor serve under a general who refused to share the booty with them.

50
Lucullus recalled, which retrieves the affairs of Mithridates.

These complaints, and the general discontent that reigned in the army, obliged the senate to recall Lucullus, and appoint Manius Acilius Glabrio, consul of that year, in his room. Glabrio arriving in Bithynia, gave notice by public criers to all the cities, that the senate had discharged Lucullus and his army, and confiscated his goods for protracting the war and refusing to comply with their injunctions. Hereupon Lucullus was abandoned by the greater part of his army, and forced to retire into Galatia, not being in a condition to make head against the joint forces of the two kings; who, laying hold of that opportunity, recovered the best part of Pontus, Bithynia, Cappadocia, and Armenia Minor: for though Glabrio had hastened into Pontus, as if he had intended to engage the enemy and rob Lucullus of the victory, yet, upon the first news of the approach of the two kings, he thought fit to retire and leave the country open on all sides to the enemy.

51
Pompey sent against him.

When this was heard at Rome, a law was enacted there by C. Manilius, a tribune of the people, whereby the management of the war against Mithridates and Tigranes was committed to Pompey, and likewise the provinces of Cilicia, then under Quintus Marcius, and of Bithynia under Glabrio. By the same law he was continued in that unlimited power by sea, with which he was invested when he first set out against the pirates of Cilicia. In virtue of this law, Pompey, who had just then ended the war with the Cilician pirates, took upon him the command of the army, and directed all the allies of the Roman people to join him with all possible expedition: but before he took the field, he renewed the alliance which Sylla and Lucullus had concluded with Phraates king of Parthia, and then

sent friendly proposals to Mithridates; who at first seemed inclined to give ear to them, and accordingly dispatched an ambassador to the Roman army to treat of a peace. Pompey required of him to lay down his arms if he was in earnest, and deliver up to him all those who had revolted from the Romans during the war. This demand was no sooner reported abroad in the king's camp, but the deserters, who were very numerous in the king's army, betaking themselves to their arms, threatened to put Mithridates himself to death; and would have occasioned a great disturbance, had not the king appeased the growing tumult, by assuring them, that he had sent ambassadors, not to treat of a peace, but only to take, under pretence of suing for peace, a view of the enemy's strength. He moreover obliged himself, by a solemn oath in the presence of the whole army, never to enter into any treaty of friendship with the Romans, nor to deliver up to them such as had ever served under him.

Pontus.
52
Mithridates rejects his proposals of peace.

Pompey, finding his proposals rejected, advanced against the king with an army of 30,000 foot and 20,000 horse, as Plutarch writes, or 30,000, as we read in Appian, all chosen troops; for he discharged most of those who had served under Glabrio and Lucullus. As he entered Galatia, he was met by Lucullus, who endeavoured to persuade him to march back, the war being near finished, and even deputies sent by the republic to settle the province of Pontus; but not being able to prevail with him, after mutual complaints against each other, they parted; and Pompey removing his camp, commanded the troops that were with Lucullus to join him, except 1600 whom he left to attend Lucullus in his triumph. From thence Lucullus set out for Rome, where he was received by the senate with great marks of esteem, most men thinking him highly injured by the authors of the Manilian law. Pompey pursued his march into Pontus; but finding that he could not by any means draw the king to a battle, he marched back into Armenia Minor, with a design either to reduce that province, or oblige Mithridates to venture a battle in order to relieve it. Mithridates followed him at some distance; and entering Armenia, encamped on a hill over-against the Romans, and, by intercepting their convoys, reduced them to such distress, that they were obliged to remove to a more convenient place, the king cutting off many in their rear, and harassing them with frequent attacks, till he fell into an ambuscade laid by Pompey, whose personal courage and prudent conduct on that occasion confirmed the king in his resolution not to hazard a general engagement. The two armies encamped over-against each other; Pompey on one hill, and the king on another, near the city of Dastira, in the province of Acisilene, at a small distance from the Euphrates, which divides Acisilene from Armenia Minor.

Here Pompey, seeing he could neither draw the king to a battle, nor force his camp, which was pitched on a steep and craggy mountain, began to block him up, with a ditch which he carried round the bottom of the hill where the king was encamped; and meeting with no opposition, finished his work, and quite cut off the enemy's communication with the country. Pompey was amazed to see the king thus tamely suffer himself to be shut up; and could not help saying, That he was either a great fool or a great coward: a fool, if he did

not.

Pontus.

not apprehend the danger he was in; a coward, if, being apprised of it, he did not to the utmost of his power prevent it. By this ditch, which was 150 furlongs in circuit, and defended by many forts raised at small distances from each other, the king was so closely besieged, that he could neither send out parties to forage, nor receive the supplies that came to him from Pontus. He was thus besieged for the space of 45 or 50 days; and his army reduced to such straits, that, having consumed all their provisions, they were at last forced to live on their dead horses. Hereupon Mithridates resolved at all events to break through the Roman fortifications: and accordingly, having put to the sword all those that were sick or disabled, that they might not fall into the enemy's hands, he attacked in the dead of the night the Roman guards; and having overpowered them with his numbers, got safe into the open fields, and continued his march all night towards Armenia Major, where he was expected by Tigranes.

54
But breaks through the Roman lines.

55
Is over-reached by Pompey, and totally defeated.

Pompey next morning by break of day pursued the enemy with his whole army; and having with much ado overtaken them, found the king encamped on a hill, to which there was but one ascent, and that guarded by a strong body of foot. The Romans encamped over-against them; but Pompey, fearing the king should make his escape in the night-time, privately decamped, and taking the same rout the enemy were to hold in order to gain Armenia, possessed himself of all the eminences and defiles through which the king was to pass. Mithridates thinking that Pompey was returned to his former camp, pursued his march, and about the dusk of the evening entered a narrow valley, which was surrounded on all sides by steep hills. On these hills the Romans lay concealed, expecting the signal to fall upon the enemy and attack them on all sides at once, while they were tired with their march, and seemingly, as they had sent out no scouts, in great security. Pompey was at first put off putting off the attack till the next morning, thinking it not safe to engage in the night-time among such steep and craggy mountains; but was at last prevailed upon, by the earnest prayers and intreaties of all the chief officers of the army, to fall upon the enemy that very night. It was therefore agreed, that in the dead of the night all the trumpets should at once sound the charge, that this signal should be followed by an universal shout of the whole army, and that the soldiers should make what noise they could, by striking their spears against the brass vessels that were used in the camp. The king's army at this sudden and unexpected noise, which was echoed again by the mountains, imagined at first that the gods themselves were come down from heaven to destroy them; and the Romans charging them on all sides with showers of stones and arrows from the tops of the hills, they betook themselves to a precipitate flight; but finding all the passes beset with strong bodies of horse and foot, were forced to fly back into the valley, where, for many hours together, they were exposed to the enemy's shot, without being able, in that confusion, either to attack them or defend themselves. They attempted indeed to make some resistance when the moon rose; but the Romans running down upon them from the hills, did not give them time to draw up, and the place was so narrow that they had not room even to make use of their swords. The king lost on that occasion 10,000

men, according to Appian, but 40,000, according to Eutropius and others. On Pompey's side there fell between 20 and 30 private men, and two centurions.

Pontus.

56

Distress of Mithridates.

Mithridates, at the head of 800 horse, broke through the Roman army, and being after this effort abandoned by all the rest, because they were closely pursued by the enemy, he travelled all night attended by three persons only, viz. his wife, or, as Plutarch calls her, his concubine, by name *Hypsicratia*, his daughter Dripetine, and an officer. At day-break he fell in with a body of mercenary horse, and 3000 foot, who were marching to join him. By these he was escorted to the castle of Sinoria, situated on the borders of the two Armenias. As great part of his treasures were lodged here, he rewarded very liberally those who accompanied him in his flight; and taking 6000 talents, withdrew into Armenia. As soon as he entered the borders, he dispatched ambassadors to Tigranes, acquainting him with his arrival; but that prince, who was then on the point of concluding a separate peace with the Romans, clapped his ambassadors in irons, pretending that his son Tigranes had, at the instigation of Mithridates, revolted first to the Parthians, and then to the Romans. Mithridates finding himself thus abandoned, even by his son-in-law, left Armenia; and directing his course towards Colehis, which was subject to him, and not as yet invaded by the Romans, passed the Euphrates the fourth day, and got safe into his own territories.

Pompey sent out several parties in pursuit of the king; but remained himself with the main body of the army in the field of battle, where he built a city, calling it from that remarkable victory *Nicopolis*. This city, with the adjoining territory, he bestowed upon such of his soldiers as were old or disabled; and many flocking to it from the neighbouring countries, it became in a short time a very considerable place. This battle was certainly attended with very fatal consequences for Mithridates; who was forced, his army being entirely either cut off or dispersed, to abandon his own dominions, and fly for shelter to the most remote parts of Scythia. Pompey having concluded a peace with Tigranes, as we have related in the history of Armenia, and settled the affairs of that kingdom, began his march in pursuit of Mithridates through those countries that lie about mount Caucasus. The barbarous nations through which he passed, chiefly the Albanians and Iberians, attempted to stop his march, but were soon put to flight. However, he was obliged, by the excessive cold and deep roads, to pass the winter near the river Cyrus. Early in the spring he pursued his march; but meeting with great opposition from the Iberians, a warlike nation, and entirely devoted to Mithridates, he was employed most part of the summer in reducing them. In the mean time, Mithridates, who had wintered at Dioscurias, on the isthmus between the Euxine and Caspian seas, and had been joined there by such of his troops as had made their escape from the late unfortunate battle, continued his flight through the countries of the Achæans, Zygiens, Heniochians, Cercetans, Moschi, and Colchians. Of these nations some received him kindly, and even entered into alliance with him; through others he was forced to make himself a way with his sword.

57
He flies into Scythia, and from thence into other countries.

Pompey took the same rout, directing his course by

Pontus.
58
Pompey's
further con-
quests.

by the stars, especially in the northern parts of Scythia, and carrying with him even provision of water, to supply the army in the vast deserts through which he marched. He spent two years in warring with these nations, and was often in danger of losing both his life and his army: but at last he overcame them all; and believing Mithridates, of whom he could have no account, to be dead, he marched back into Armenia Minor, where he allowed some rest to his soldiers, who were quite worn out with the hardships they had endured in that expedition. Having refreshed his army, he marched into Pontus, to reduce some strongholds which were still garrisoned by the king's troops. While he was at Aspis in Pontus, many of the king's concubines were brought to him; but he sent them all home to their parents, without offering them the least injury, and thereby gained the affection of the chief lords of Pontus, whose daughters they were. The strong castle of Symphori was delivered up to him by Stratonix, one of the king's concubines, upon no other terms than that he would spare her son Xiphæres, who was with the king, in case he should fall into his hands. She likewise discovered to him great treasures hid under ground, which he, with great generosity, bestowed upon her, reserving for himself only some vessels to set off his triumph. Having taken another fort, called the *New Castle*, and to that time looked upon as impregnable, he found in it great store of gold, silver, and other valuable things, which he afterwards consecrated to Jupiter Capitolinus. Here, in looking over the king's manuscripts, he came to discover where the rest of his treasures were concealed, what troops he could raise and maintain, what sums were yearly paid him by his subjects and tributaries, &c. whereby he could make a true estimate of his whole power and wealth. Amongst other manuscripts he found some books of physick, wrote by Mithridates himself, which he commanded Lenæas, a learned grammarian, to translate into Latin.

59
Mithridates ap-
pears again
at the head
of a consi-
derable ar-
my.

Pompey, having thus reduced all Pontus, marched into Syria, with a design to recover that kingdom, and passing through Arabia to penetrate as far as the Red Sea. But while he was employed in this expedition, news was brought him that Mithridates, whom he believed dead, had appeared unexpectedly in Pontus at the head of a considerable army, and surprised Panticapæum, a famous emporium at the mouth of the Euxine Sea. He had lain all this time concealed in the territories of a Scythian prince, adjoining to the Palus Mæotis; but hearing that Pompey had left Pontus, and was engaged in other wars, he ventured out of his hiding-place, resolved either to recover his paternal kingdom, or die in the attempt. He returned privately into Pontus and managed matters there so dexterously, that the Roman garrisons knew nothing of his arrival till he appeared with a considerable army in the field. He advanced first to the castle of Symphori; and understanding that Stratonix had delivered it up to Pompey, on condition he would save the life of her son in case he should take him prisoner, the king immediately caused the youth, who was in his army, to be put to death, and his body to be left unburied, Stratonix beholding from the walls the cruel and unnatural murder, for he was her son by Mithridates, and had served him with great fidelity.

At the same time he sent ambassadors to Pompey to treat of a peace, offering to pay a yearly tribute to the republic, on condition he restored to him his kingdom. Pompey replied, that he would hearken to no proposals whatsoever, without the king came to treat with him in person, as Tigranes had done. This Mithridates looked upon as nowise consistent with his dignity; and therefore laying aside all thoughts of an accommodation, began to make what preparations he could for renewing the war.

Pontus.

He summoned all his subjects that were able to bear arms to meet at an appointed place; and having chosen out of the whole multitude 60 cohorts, each consisting of 100 men, he incorporated them with the regular troops that were already on foot. Being now in a condition to act offensively, for Pompey had left but a small number of troops in Pontus he possessed himself of Phanagorium, Chersonesus, Theodosia, Nymphæum, and several other important places. But in the mean time, Castor, whom Mithridates had appointed governor of Phanagorium, falling out with Tripho, one of the king's favourite eunuchs, killed him, and dreading the king's resentment, stirred up the inhabitants to a revolt: by which means Phanagorium was again lost; but the castle, which was defended by four of the king's sons, Artaphernes, Darius, Xerxes, and Oxathres, held out for some time. The king hastened to their relief; but the castle being set on fire by the rebels, they were forced to surrender themselves to Castor before his arrival. These four sons, with one of the king's daughters, by name *Cleopatra*, Castor sent to the Romans; and fortifying himself in the town, persuaded most of the neighbouring cities, which were oppressed with heavy taxes, and strangely harassed by the king's collectors, to join in the rebellion.

60

Recovers
several
places.

Mithridates finding that he could neither rely upon the soldiery, most of them being forced into the service, nor on his other subjects, who were dissatisfied by reason of the exorbitant taxes, sent ambassadors to invite the princes of Scythia to his relief, and with them his daughters, to be bestowed in marriage upon such as showed themselves most inclined to assist him. But as the ambassadors he employed on this occasion were eunuchs, a race of men no less abhorred by the army than favoured by the king, over whom they had a great ascendant, especially in his old age, the soldiers who were sent to attend them on their journey, put them all to the sword as soon as they were out of the king's reach, and delivered his daughters up to the Romans. Mithridates, finding himself thus deprived of his children, betrayed by his army, and forsaken even by those on whom he chiefly relied, could not yet be induced to submit to the Romans, though Pompey promised him honourable conditions, provided he came to treat with him in person. In this desperate condition, he left no stone unturned to stir up the princes of Asia against the Romans, especially the Parthians; but finding them awed by the great opinion they all had of Pompey he had recourse at last to the European Gauls whom he understood to be at war with the Romans; and having sent before some of his trusty friends to engage them in his favour, taking leave of his own kingdom, he began his long march, designing to pass through Bosphorus, Cimmerius, Scythia,

61

His subjects
discontent-
ed.

62

His extra-
ordinary
design of
invading
Italy.

Pontus.

thia, Panonia, &c. and joining the Gauls, pass the Alps, and invade Italy.

This design was no sooner known in the army, but the soldiers openly began to complain and mutiny; exaggerating the boldness of the attempt, the length of the march, and the unsurmountable difficulties that must necessarily attend such a desperate enterprise. The chief commanders did all that lay in their power to divert him from it; representing to him, that if he was not able to cope with the Romans in his own kingdom, much less would he be a match for them in Italy or Gaul, where they could daily receive new supplies; whereas he would lose the greatest part of his army in so long and difficult a march, and the rest perhaps in the first engagement, without any possibility of repairing the loss. But all was to no purpose; for they found him so unalterably fixed in his resolution, that he caused those to be put to death who with most warmth remonstrated against it, not sparing even his own son Exipodras, for dropping some unguarded expressions on that occasion. Thus they were forced to let him pursue his own measures, till they found a more proper opportunity to oppose them, which soon after offered, as they were encamped at Bosphorus Cimmerius, on their march into Scythia.

63
His son
Pharnaces
revolts.

Here Pharnaces, the king's favourite son, whom he had appointed to succeed him, observing the general discontent that reigned in the army, began to entertain thoughts of placing the crown on his own head; and not doubting but the soldiery would stand by him, if he declared against the intended expedition into Italy, openly protested among the Roman deserters, who were a considerable part of the army, that if they would follow him he would return into Pontus. The Romans, who were well apprised of the danger that attended such an undertaking, and had most of all exclaimed against it, promised to support him to the utmost of their power, and even encouraged him, upon some expressions which he purposely dropped, to assume the title of *king*, a title which his father seemed determined to hold till he had destroyed, by his rash and desperate attempts, himself, his friends, and his army. Pharnaces, finding he could depend on the Romans engaged the same night most of the chief commanders in his party, and by their means the greater part of the soldiery. It was agreed, that next morning by break of day all those who had declared in his favour should appear in arms, and with a loud shout proclaim Pharnaces king; which was done accordingly, and the shout returned even by those whom Pharnaces had not thought fit to let into the secret. The king, who had taken up his quarters in the city, being awaked by the noise, sent out some of his domestics to know what had happened in the army. Neither did the officers or soldiers dissemble the matter, but boldly answered, that they had chosen a young king instead of an old dotard governed by eunuchs.

Hereupon Mithridates mounting on horseback, and attended by his guards, went out to appease the tumult: but his guards forsaking him, and his horse being killed under him, he was obliged to fly back into the city; from whence he sent several of his attendants one after another to desire of his son a safe conduct for himself and his friends. But as none of the messengers returned, some being slain, and others siding

with the new king, Mithridates endeavoured to move his son to compassion, by signifying to him from the walls the distressed condition he was reduced to by a son whom he had favoured above the rest of his children; but finding him nowise affected by his speech, turning to the gods, he beseeched them with many tears to make his son know one day by experience the grief and agony which a father must feel in seeing his love and tenderness requited with such ungrateful and monstrous returns. Having thus spoke, he thanked in a very obliging manner those who had stood by him to the last, and exhorted them to make their submission to the new king on the best terms they could procure; adding, that as for himself, he was determined not to outlive the rebellion of a son whom he had always distinguished with particular marks of paternal affection.

Pontus.

After this, he withdrew into the apartment of his wives and concubines, where he first took poison himself, and then presented it to them, and to his favourite daughters Mithridatis and Nissa, who not long before had been betrothed to the kings of Egypt and Cyprus. To the women it proved immediate death; but on the king, who from his infancy had inured his constitution to poisonous potions, it had so slow an operation, that he was forced, through fear of falling into the rebels hands, to recur to his sword. Neither did the wound, as he was greatly weakened by the poison, prove mortal: so that the rebels, having in the mean time stormed the town, and broke into the house, found the king wallowing in his blood, but still alive, and in his senses; which Pharnaces hearing, sent some of those that were about him to dress his wounds, with a design to deliver him up to the Romans, and thereby ingratiate himself with Pompey.

64
Mithridates attempts to destroy himself.

But, in the mean time, a Gaul, who served in the army, by name *Bitetius*, or *Bithocus*, entering the king's room in quest of booty, and being touched with compassion in seeing him forsaken by all his friends, and struggling on the bare ground with the pangs of death, drawing his sword, put an end to his present agonies, and prevented the insults which he chiefly apprehended if he should fall alive into his son's hands. The barbarian is said, when he first saw the king, to have been so awed with the majesty of his countenance, that, forgetful of his booty, he fled out of the room; but being called back, and earnestly intreated by the dying prince to put an end to his misery, he summoned all his courage to perform, as he did, with a trembling hand, that office; and immediately retired without touching any thing that belonged to the king, though the hopes of a rich booty was the only motive that had led him thither.

65
A Gaul puts an end to his life out of compassion.

Pompey, who was at that time engaged in a war with the Jews, received the first notice of the death of Mithridates as he was on his march to Jerusalem. The messenger who brought the joyful tidings was sent by Pharnaces, and appeared unexpectedly before Pompey with the branch of a laurel, as was customary on the like occasions, twisted round the head of his javelin. When he heard what had happened at Panticapæum, he was so impatient to impart it to the soldiery, that he could not even wait till they had raised him a mound of turf from whence to speak to the army, according to the custom of the camp; but ordered those

66
Excessive joy of the Romans at his death.

Pontus

those who were by him to form a kind of mount with their saddles, and from thence acquainted the soldiery that Mithridates had laid violent hands on himself, and his son Pharnaces was ready to acknowledge the kingdom as a gift of the people of Rome, or resign it if they were unwilling he should reign. This news was received with joyful shouts of the whole army, and the day solemnized with feasts and sacrifices throughout the camp, as if in Mithridates alone all the enemies of the republic had died. Pompey dispatched without delay a messenger with letters to the senate, acquainting them with the death of Mithridates, and the submission of his son Pharnaces. When his letters were read, the senators were so overjoyed, that they appointed, at the proposal of Cicero, then consul, 12 days for returning due thanks to the gods, who had delivered them from such an insulting and powerful enemy; and the tribunes of the people enacted a law, whereby Pompey, in consideration of his eminent service in the Mithridatic war, was to wear a crown of laurel, with the triumphal gown at the Circensian sports, and a purple gown at the scenical plays.

67
Submissive
embassy of
Pharnaces
to Pompey;

Pharnaces, when he heard of his father's death, caused his body to be preserved in brine, proposing to present it to Pompey, who had promised to return into Pontus after the reduction of Judæa, and there settle matters to his satisfaction. And accordingly having taken the city and temple of Jerusalem, he set out with two legions for Pontus; and being arrived at Sinope, he was there met by ambassadors from Pharnaces, acquainting him, that their master had forbore assuming the title of king till his will and pleasure were known; that he put both himself and the kingdom entirely into his hands; and that he was willing to attend him at what time or place he thought fit to appoint. The same ambassadors delivered up to Pompey those who had taken Manius Aquilius the Roman legate, whom Mithridates had put to a cruel death, all the prisoners, hostages, and deserters, whether Romans, Greeks, or Barbarians, and the body of Mithridates, with his rich apparel and arms, which were greatly admired by Pompey and the other Romans. Both soldiers and officers flocked to see the king's body; but Pompey declined that sight; and, saying that all enmity between that great prince and the people of Rome was ended with his life, he returned the body to the ambassadors, and caused it to be interred with the utmost pomp and magnificence among his ancestors in the burying-place of the kings of Pontus, Pompey defraying all the charges of that ceremony, which was the most costly and pompous that ever had been seen in those parts. With the body Pompey restored his wearing apparel and armour; but the scabbard of his sword, which cost 400 talents, was stolen by Rublius a Roman, and sold to Ariarathes king of Cappadocia; and his cap or turban, which was a very curious piece of workmanship, was privately taken by one Caius, who presented it to Faustus the son of Sylla, in whose house it was kept, and shown for many years after among the many rarities which Sylla had brought out of Asia.

Pompey bestowed the kingdom of Bosphorus on Pharnaces, and honoured him with the title of a friend and ally of the people of Rome. Pharnaces being thus acknowledged king of Bosphorus, sent orders

Pontus

to all the garrisons of Pontus to submit themselves, with the castles and treasures with which they were entrusted, to Pompey, who by that means amassed an immense booty. In the city of Talaura, which Mithridates used to call his wardrobe, he found 2000 cups of onyx set in gold, with such store of gold and silver vessels, of costly furniture, of saddles, bridles, and trappings, set with jewels and precious stones, that the Roman commissaries spent 30 days in taking the inventory of the whole. In another castle he found three large tables with nine salvers of massy gold, enriched with precious stones to an inestimable value; the statues of Minerva, Mars, and Apollo, of pure gold and most curious workmanship; and a pair of gaming-tables of two precious stones, three feet broad, and four feet long, on which was a moon of gold weighing 30 pounds, with their men, all of the same precious stone. In a sort situated among the mountains, were delivered up to him the king's statue of massy gold, eight cubits high, his throne and sceptre, and the bed of Darius the son of Hytaspes. Most of these treasures had been transmitted to him from his ancestors, chiefly from Darius king of Persia; some belonged to the Ptolemies of Egypt, and had been deposited by Cleopatra, as we have hinted above, in the hands of the Coans, who delivered them to Mithridates; and great part of them had been collected by the king himself, who was very fond of rich and stately furniture.

Pompey having thus got entire possession of Pontus, and reduced it to the form of a Roman province, ⁶⁸ Who be-
marched into *Asia* properly so called; and having win-
tered at Ephesus, early in the spring set out for Italy, ^{him the}
with a fleet of 700 ships. As he brought over his kingdom of
army with him, the senate was under no small apprehension lest he should make himself absolute, and rule without controul. But he no sooner landed at Brundisium, than he disbanded the army, without waiting for any decree either of the senate or people; what neither his friends nor his enemies had believed. His triumph lasted two whole days; and though he was attended in his triumphal chariot by 324 captives of distinction, among whom were five sons and two daughters of Mithridates, yet he would not suffer any of them to be put to death, as had been done by others; but sent them all back, except such as were of royal extraction, to their respective countries, and even supplied them with money to defray the charges of their journey. After his triumph he delivered into the treasury 20,000 talents, though, at the dismissing of the army, he had divided 16,000 talents among the tribunes and centurions, 2000 sestertiums among the quæstors, and had given to each soldier 50 sestertiums.

Pompey had no sooner left Asia, but Pharnaces fell ⁶⁹ Pharnaces
unexpectedly upon the Phanagorenses, a people of ^{falls out}
Bosphorus, whom Pompey had declared free, because with the
they had revolted the first of all from Mithridates, and ^{kingdom of}
by their example induced others to abandon the king's ^{Romans.}
party. Pharnaces besieged their chief city Phanagoria, and kept them blocked up till, for want of provisions, they were forced to fall out, and put all to the issue of a battle; which proving unsuccessful, they delivered up themselves and their city to the conqueror. Some years after, the civil war breaking out between Cæsar and Pompey, he laid hold of that opportunity

Pontus

to recover the provinces which his father had formerly possessed; and having raised a considerable army, overran Pontus, Colchis, Bithynia, Armenia, and the kingdom of Moschis, where he plundered, as Strabo observes, the temple of the goddess Leucothea. He took the strong and important city of Sinope, but could not reduce Amisus. But, in the mean time, Cæsar having got the better of Pompey and his party, appointed Cn. Domitius Calvinus governor of Asia, enjoining him to make war upon Pharnaces with the legions that were quartered in that province. Domitius immediately dispatched ambassadors to Pharnaces, commanding him to withdraw his troops from Armenia and Cappadocia. The king returned answer, that he was willing to abandon Cappadocia, but as for the kingdom of Armenia Minor, it was part of his hereditary dominions; and therefore he would not resign it till he had an opportunity of laying his pretensions before Cæsar himself, whom he was ready to obey in all things. Hereupon Domitius drawing together what forces he could, marched into Cappadocia, which he recovered without opposition, Pharnaces having abandoned it to make a stand in Armenia, which lay nearer his own dominions. Thither Domitius pursued him; and having overtaken him near Nicopolis, found his army drawn up in battle-array, and the king ready to come to an engagement; which Domitius not declining, both armies advanced.

70
And de-
feats them.

The king, at the head of a choice body of men, fell upon the Romans left wing, consisting mostly of raw and undisciplined Asiatics; and having without much ado put them to flight, penetrated to the centre, where the thirty-fifth legion, the only one which Domitius had, after a faint resistance, gave ground, and, retiring to the neighbouring mountains, left their allies to shift for themselves, who were all cut off. Domitius with the remains of his scattered army marched back into Cappadocia; and from thence, winter drawing on, into the province of Asia. The king being puffed up with this victory, and hearing that Cæsar, with the flower of the Roman forces, was engaged at the siege of Alexandria, appointed one Asander governor of Bosphorus, and marched himself into Cappadocia in pursuit of Domitius, with a design to invade Asia, and recover all the provinces which had been once subdued by his father. Bithynia and Cappadocia readily submitted; but Armenia the Lesser, which was held by Dejotarus, made so vigorous a resistance, that he was forced to give over the enterprise, lest the Romans should in the meantime strengthen themselves in Asia, whither he was in haste to march, in hopes of meeting there with the same success as his father Mithridates had done. But before he reached that province, he was informed that Asander had revolted, in hopes of gaining thereby the good-will of the Romans, and obtaining of them the kingdom of Bosphorus for himself. At the same time, he received intelligence that Cæsar, having at last reduced Alexandria, and settled the affairs of Egypt and Syria, was marching into Armenia.

71
Attempts
to outwit
Julius Cæ-
sar,

He was not a little dismayed at this news, and therefore without delay dispatched ambassadors to sue for peace; hoping that Cæsar, who was hastening into Italy with a design to pass over into Africa, would willingly give ear to any proposals of that nature.—

Vol. XV. Part I.

Cæsar courteously entertained the ambassadors; and though he did not propose to agree to their conditions, yet, that he might come upon Pharnaces unawares, he showed himself very desirous of entering into a treaty of peace. But, in the mean time, he pursued his march with all possible expedition; and arriving on the confines of Pontus, ordered all the troops that were quartered in the neighbouring provinces to join him; for he had brought from Alexandria but one legion, namely, the sixth, and that consisting of 1000 men only, the rest having been killed at the siege of Alexandria. Besides this veteran legion, he found at the place of general rendezvous three others, but all of them very indifferently armed, and worse disciplined. With these forces, however, such as they were, he advanced against Pharnaces; who being greatly frightened at his approach, by reason of the success that had attended him in all his expeditions, again dispatched ambassadors to him with a crown of gold, offering him his daughter in marriage, and promising to do whatever he should require. The ambassadors took care to let him know that their master, though highly obliged to Pompey, yet had never been prevailed upon to send him any supplies during the civil war, which Dejotarus, king of Armenia the Lesser, whom he had honoured with his friendship, had done. Cæsar returned for answer, that he was willing to conclude a peace with Pharnaces, provided he retired without delay from Pontus, returned all the captives and hostages whether Roman or their allies, and restored the goods of the Roman citizens and publicans which he had seized since he first took up arms. He added, that as to his not sending supplies to Pompey, they ought rather to have concealed such an ungrateful proceeding of their master, than alleged it as any merit, since the forsaking of one to whom he was indebted for his crown, bespoke him a man of mean, selfish, and unworthy principles.

Pharnaces, upon the return of his ambassadors, acquainted Cæsar that he agreed to the conditions; but finding that Cæsar's affairs called him into Italy, he required a longer term of time for the performance of what was stipulated between them, starting daily new difficulties, in hopes that Cæsar would in the mean time be obliged to depart, and leave the affairs of Pontus in the same posture he had found them. Cæsar seeing himself disappointed, and put off from day to day, could not longer brook the king's deceitful behaviour. Wherefore he determined to put himself at the head of his small army, and attack the enemy in his camp when he least expected it. And accordingly, marching out in the night, he came by break of day in sight of the king's army; and uttering these words, *Shall this treacherous parricide go unpunished?* broke into the camp at the head of 1000 horse. The king's chariots, which were armed with scythes, caused some small disorder among Cæsar's horse; but in the mean time the rest of his army coming up, he put the enemy to flight, and obtained a complete victory. This battle was fought near the place where Mithridates had routed with great slaughter the Roman army under the command of Triarius. Most of the king's army were either taken or cut in pieces; but Pharnaces himself had the good luck to make his escape while the Romans were busy in plundering the camp. This victory was so quick, that

72
By whom
he is en-
tirely de-
feated.

3 A

Cæsar

Pontus. Cæsar in a letter to his friend Aminitius, or Anitius, at Rome, expressed it in three words, thus: "I came, I saw, I conquered." He ever afterwards used to call Pompey a fortunate rather than a great commander, since he had gained his chief glory in the Mithridatic war, fighting with so cowardly an enemy. He divided the rich booty and the spoils of the camp among his soldiers; and because Mithridates had erected a trophy near that place as a monument of his victory over Triarius, which Cæsar, as it was consecrated to the gods, did not think lawful to pull down, he set up another over-against it to transmit to posterity his victory over Pharnaces. After this victory he recovered and restored to the allies of the people of Rome all the places which Pharnaces had possessed himself of during the war, declared Amisus a free city, and appointed Mithridates Pergamenus king of Bosphorus in the room of Pharnaces.

Having thus settled the affairs of Pontus, he set sail for Italy; leaving Domitius Calvinus to pursue the war against Pharnaces, if he should appear again in the field. Pharnaces had retired after the battle to Sinope with 1000 horse, where he was quickly besieged by Domitius, to whom he surrendered the town, upon no other condition than that he should be suffered to retire into Bosphorus with the small body that attended him. This Domitius willingly granted; but caused all the king's horses to be killed, since he had asked a safe-conduct only for his horsemen. With these and a band of Scythians and Sarmatians he attempted to recover the kingdom of Bosphorus; but being met between Theodocia and Panticapeum, both which cities he had reduced, by Asander, who was still in possession of the kingdom, a sharp engagement ensued, wherein the king's men, as not being used to fight on foot, were put to flight, and Pharnaces himself, who remained alone in the field, was surrounded by the enemy, and cut in pieces, after having reigned in Bosphorus Cimmerius, the kingdom which Pompey had bestowed upon him, according to Appian, fifteen years, according to others, seventeen.

73
Is killed in another engagement.

Upon the death of Pharnaces the kingdom of Pontus was again reduced to the form of a province, and so continued to the triumvirate of Marc Antony, who after the battle at Philippi conferred it upon Darius the son of Pharnaces for his services during the civil war. He continued faithful to the Romans; but did nothing during his reign worth mentioning.

74
Pontus again made a kingdom by Marc Antony.

Darius was succeeded in the kingdom by Polemon, likewise preferred to that honour by Marc Antony. He was the son of Zeno, a famous orator of Laodicea, and greatly favoured by Antony. From him that part of Pontus which borders on Cappadocia borrowed the name of *Polemoniæus*. He attended Marc Antony in his expedition against the Parthians; and being taken prisoner in that unsuccessful battle fought by Statianus, he was sent by the king of the Medes, an ally of the Parthians, to conclude a peace with the Romans. In which embassy he acquitted himself so well, that Antony added the kingdom of Armenia to his own dominions. In the war between Antony and Augustus he sided with the former: but after the battle of Actium he was received into favour by the latter; and being sent by Agrippa against Scribonius, who upon the death of Asander had usurped the kingdom of Bosphorus, he overcame him,

and reduced the kingdom of Colchis, which was bestowed upon him by Agrippa, who likewise honoured him with the title of *friend and ally of the people of Rome*. He afterwards waged war with the neighbouring barbarians refusing to live in subjection to the Romans; but was overcome, taken, and put to death, by the Aspurgitani, a people bordering, according to Strabo, on the Palus Mæotis.

Upon his death his son Polemon II. was by the emperor Caligula raised to the throne of Bosphorus and Pontus. But the emperor obliged him to exchange the kingdom of Bosphorus with part of Cilicia; and Nero, with his consent, reduced that part of Pontus which he enjoyed to the form of a province. He fell in love with Berenice, daughter to Agrippa king of Judæa; and in order to marry her embraced the Jewish religion. But as she soon became tired of his riotous way of living, and returned to her father; so he renounced his new religion, and again embraced the superstitions of Paganism.

75
Is parcelled out into several provinces.

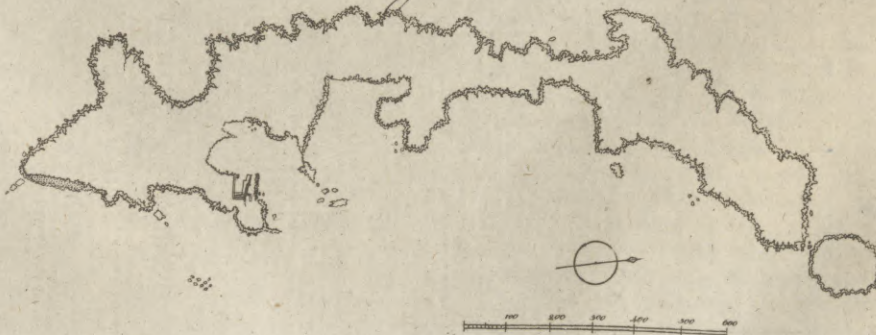
Polemon dying without issue, the ancient kingdom of Pontus was parcelled out into several parts, and added to the provinces of Bithynia, Galatia, and Cappadocia, only that part of it which was called *Pontus Polemoniæus* retaining the dignity of a distinct and separate province. During the civil discords between Vespasian and Vitellius, one Anicetus, first a slave, afterwards freedman, to king Polemon, and lastly commander of the royal navy, took up arms with a design to rescue the kingdom from the Roman bondage; and being joined by great multitudes drawn together with the prospect of spoil, over-ran the country, and possessed himself of Trapezund, a city founded by the Grecians on the utmost confines of Pontus. Here he cut in pieces a cohort made up of the inhabitants, but which had been formerly presented with the privilege of Roman citizens. He likewise burnt the fleet, and with scorn and insults scoured the sea; Mucianus having called to Byzantium most of the Roman galleys. Hereupon Vespasian, who was at that time in Syria, sent Verdius Gemnius into Pontus with a choice body of auxiliaries from the legions. He assailing the enemy while they were in disorder, and roaming asunder in pursuit of prey, drove them into their vessels; then with some galleys chased Anicetus into the mouth of the river Chobus, where he thought himself safe under the protection of Sedochus king of the Lazians, whose alliance he had purchased with large sums and rich presents. Sedochus at first refused to deliver him up to the Romans; but was soon prevailed upon, partly by threats, partly by presents, to surrender both him and all the other fugitives who had taken sanctuary in his dominions. Thus ended that servile war; and the kingdom of Pontus continued to be a province of the empire till the time of David and Alexis Comneni, who being driven from Constantinople by the French and Venetians A. D. 1204, under the command of Baldwin earl of Flanders, settled, the one at Heraclea, the other at Trebifond. The troubles that arose among the Latins gave Alexis Comnenus an opportunity of erecting here a new empire, which comprehended great part of Pontus, and was known by the name of the *empire of Trebifond*. The Comneni held it about 250 years, till the time of Mohammed II. who carried David Comnenus, the last emperor of Trebifond, prisoner to Constantinople, A. D. 1462, with all his family, and subjected his empire to that of Constantinople;



Fig. 2.



Fig. 1.



Portypool, nople; in which abject slavery Trebifond and all Pontus have continued ever since.

PONTYPOOL, a town of Monmouthshire in England, seated between two hills. It is but a small place, though noted for its iron-mills, great manufacture of jappaned mugs, &c. W. Long. 3. 6. N. Lat. 51. 42.

PONZA, or PONTIA, is a small island of the Tuscan Sea, well known to be the place to which many illustrious Romans were formerly banished. It is situated on the coast of Italy near Terracina, and in the neighbourhood of other small islands or rocks named *Palmarole*, *Zannone*, &c. between the island of Ventotienne and Monte Circello. All these islands were visited by Sir William Hamilton in the year 1785; and an account of his journey is given in a letter to Sir J. Banks, which appeared in the *Phil. Trans.* vol. lxxvi. p. 365. Sir William arrived at Ponza on the 20th August; and, according to his account, it lies about 30 miles from Ventotienne. On the 21st he went round it in a boat. Its length is about five miles, but its breadth is nowhere above half a mile, and in some places not more than 500 feet. It is surrounded by a multitude of detached rocks, some of them very high, and most of them composed of a compact lava. There are many irregularly formed basaltic, but none in large columns. In some places they have a reddish tinge from iron ochre, are very small, and irregularly laid over one another. Some stand perpendicularly, others obliquely, and some lie horizontally. The rocks themselves in which these masses are found are lava of the same nature with the basaltic. At first sight they appear like the ruins of ancient Roman brick or tile buildings. One rock is composed of large spherical basaltic, and in other places our author found the lava inclined to take the like spherical form, though on a much smaller scale, some of the former basaltic being near two feet in diameter. All these rocks, in our author's opinion, have been detached by the sea from this island, which is entirely composed of volcanic matter, lavas, and tufas of various qualities and colours, as green, yellow, black, and white. Some of these matters are more compact in their texture than others; and in some parts great tracts seem to have undergone similar operations, which still subsist at a spot called the *Pisciarelli*, on the outside of the Solfatara, near Puzzole, and where a hot sulphureous vitriolic acid vapour converts all which it penetrates, whether lavas, tufas, volcanic ashes, or pumice-stones, into a pure clay, mostly white, or with a tint of red, blue, green, or yellow.

In one part of this island there is a sort of tufa remarkably good for the purpose of building. It is as hard as Bath-stone, and nearly of the same colour, without any mixture of lava or pumice-stone, which usually abound in the tufas of Naples, Baia, and Puzzoli.

The island of *Palmarole* which is about four miles from Ponza, is not much more than a mile in circumference. It is composed of the same volcanic matter, and probably was once a part of Ponza; and in our author's opinion it looks as if the island of *Zannone*, which lies about the same distance from Ponza, was once likewise a part of the same; for many rocks of lava rise above water in a line betwixt the two last-mentioned islands, and the water there is much more shallow than in the gulf of Terracina.

Zannone is much larger and higher than *Palmarole*;

and that half of it next the continent is composed of a lime-stone similar to that of the Apennines near it; the other half is composed of lavas and tufas, resembling in every other respect the soil of the islands just described. Neither *Palmarole* nor *Zannone* are inhabited; but the latter furnishes abundance of brushwood for the use of the inhabitants of Ponza, whose number, including the garrison, amounts to near 1700. The uninhabited island of *St Stefano* in like manner furnishes wood for the people of Ventotienne. It is probable that all these islands and rocks may in time be levelled by the action of the sea. Ponza, in its present state, is the mere skeleton of a volcanic island; little more than its hard or vitrified parts remaining, and they seem to be slowly and gradually mouldering away. The governor of the castle of Ponza, who had resided there 53 years, told our author that the island was still subject to earthquakes; that there had been one violent shock there about four years before; but that the most violent one he ever felt was on the very day and at the hour that Lisbon was destroyed. Two houses out of three which were then on the island were thrown down. "This (says our author) seems to prove that the volcanic matter which gave birth to these islands is not exhausted."

Fig. 1. Plate CCCCXII. is a plan of the island of Ponza as it is given in the *Philosophical Transactions*. Fig. 2. is a view of the inside of the harbour of the island. A in the same figure is a rock of lava. In many parts it is formed into regular basaltic of a reddish colour, tinged in all probability with some ochre. Most of the detached rocks of the island resemble this. BB represents a tract of volcanic country, converted by a hot sulphureous vitriolic acid vapour into a pure clay, the ground colour of which is mostly white.—Fig. 3. is a view from the outside of the harbour, near the lighthouse. C is a rock of volcanic matter converted to pure clay; D is a rock of the same kind, with strata of pumice-stone: E is a rock of lava, inclining to take basaltic forms; and F is a rock composed of spherical basaltic.

POOD is a Russian weight, equal to 40 Russian or 36 English pounds.

POOL is properly a reservoir of water supplied with springs, and discharging the overplus by sluices, defenders, weirs, and other caufeways.

POOL, a sea-port town of Dorsetshire in England. It is surrounded on all sides by the sea, except on the north, where there is an entrance through a gate. It was formerly nothing but a place where a few fishermen lived: but in the reign of Henry VI. it was greatly enlarged, and the inhabitants had the privilege to wall it round. It was also made a county of itself, and sent two members to parliament. It is governed by a mayor, a senior bailiff, four other justices, and an indeterminate number of burgesses. The town consists of a church and about 600 houses, with broad paved streets; and has a manufactory of knit hose. It is 47 miles west-south-west of Winchester, and 110 west-by-south of London. W. Long. 2. 0. N. Lat. 50. 42.

POOLE (Matthew), a very learned writer in the 17th century, was born at York in 1624. He was educated at Emanuel-college, Cambridge, and afterwards incorporated in the university of Oxford. He succeeded Dr Anthony Tuckney in the rectory of St Michael de Quern, in London, about 1648. In 1658

Poor,
Poor.

Poor.

he set on foot a project for maintaining youths of great parts at the universities, and had the approbation of the heads of houses in both of them. He solicited the affair with so much vigour, that in a short time 900 l. *per annum* was procured for that purpose; but this design was laid aside at the Restoration. In 1662 he was ejected from his living for nonconformity. He was ten years employed in composing his *Synopsis Criticorum*, &c. Besides this great work he published several other pieces. When Dr Oates's depositions concerning the popish plot were printed, our author found his name in the list of those who were to be cut off, on the account (as was supposed) of what he had written against the papists in his *Nulity of the Romish Faith*. So that he was obliged to retire into Hollaud, where he died in 1679, and left behind him the character of a very able critic and casuist.

POOP, the stern of a ship; or the highest, uppermost, and hinder part of a ship's hull. See STERN.

POOR, in law, an appellation given to all those who are in such a low and mean condition, that they either are or may become a burden to the parish.

They who rank pity amongst the original impulses of our nature rightly contend, that when it prompts us to the relief of human misery, it indicates sufficiently the Divine intention, and our duty. Indeed, the same conclusion is deducible from the existence of the passion, whatever account be given of its origin. Whether it be instinct, or a habit founded in association (see PASSION), it is in fact a property of our nature which God appointed: and the final cause for which it was appointed is to afford to the miserable, in the compassion of their fellow-creatures, a remedy for those inequalities and distresses to which many are necessarily exposed under every possible rule for the distribution of property. That the poor have a claim upon the rich, founded in the law of nature, can be questioned by no man who admits the benevolence of the Deity, and considers his purpose in creating the world (see THEOLOGY, Part I. Sect. ii.); and upon this claim the Christian Scriptures are more explicit than almost upon any other.

The rights of the poor, however, to be relieved by the rich, as they originate in nature, and are sanctioned by Christianity, are evidently of that kind which is called *imperfect* (See *MORAL Philosophy*, n° 151.) It is surely needless to warn our readers in this place, that imperfect rights are in themselves as sacred, and the duties resulting from them as obligatory in *foro conscientiae*, as the most rigid claims of justice. Every one knows, that they are called *imperfect* only because the extent of them in particular instances cannot be ascertained by positive laws, nor the breach of them be punished by the civil magistrate. Hence the apostle, tho' he enjoins a weekly contribution to be made for the poor in the church of Corinth, yet leaves the sum to be contributed by each individual wholly undetermined. "Now concerning the collection for the saints, as I have given order to the churches of Galatia, even so do ye. Upon the first day of the week let every one of you lay by him in store as God hath prospered him." By which St Paul certainly recommends to every man to contribute, not a fixed sum, but as much as, from a deliberate comparison of his fortune, with the reasonable

expences and expectations of his family, he finds he can spare for charitable purposes.

It is well known that those weekly contributions were laid at the feet of the apostles, who transferred the management of the fund thence arising to deacons elected by the people, and ordained by them to see that the money was properly distributed. Hence, under Christianity, the maintenance of the poor became chiefly an ecclesiastical concern; and when that holy and benevolent religion was established in the Roman empire, a fourth part of the tithes was in some countries of Europe, and particularly in England, set apart for that purpose. Afterwards, when the tithes of many parishes were appropriated to the monasteries, these societies were the principal resource of the poor, who were farther relieved by voluntary contributions. Judge Blackstone observes, that till the statute 26 Hen. VIII. cap. 26. he finds no compulsory method for providing for the poor; but upon the total dissolution of the monasteries, abundance of statutes were made in the reign of King Henry VIII. Edward VI. and Elizabeth, which at last established the

Poor's Rate, or legal assessment for the support of the poor. The sums that had been appropriated for charitable uses before the reformation were immense, and the wealth that had been accumulated through a succession of ages by mendicant orders of religious persons was inconceivably great; nor was it in the power of any laws to confine men who were in the possession of such wealth from gratifying those desires which money can so easily find means of supplying. Yet among the various abuses to which this opulence had given rise, these religious orders had never so far lost sight of their original institution as ever to neglect the poor. These were indeed provided for by them with an indiscriminate profusion of largesse, better proportioned to their own opulence than to the wants of the claimants, who were too often, without examination, all equally served, whether deserving or undeserving of that bounty which they claimed.

When the *religious houses*, as they were called, were entirely suppressed at the reformation, and the wealth that belonged to them was diverted into other channels, the poor, who had been in use to receive their support from thence, were of course left entirely destitute; and this soon became a grievance so intolerable not only to the poor themselves, but to the whole nation, as to excite a universal desire to have it remedied. Accordingly, by the 14 Eliz. cap. 5. power was given to the justices to lay a general assessment; and this hath continued ever since. For by 43 Eliz. cap. 2. the churchwardens and overseers of the poor of every parish, or the greater part of them (with the consent of two justices, one of whom is of the quorum, dwelling in or near the parish), are empowered to raise weekly, or otherwise, by taxation of every inhabitant, parson, vicar, and other, and of every occupier of lands, houses, &c. materials for employing the poor, and competent sums for their relief. Notice shall be given in church of every such rate the next Sunday after it is allowed, which may be inspected by every inhabitant, paying 1 s. and copies of it granted on demand, 6 d. being paid for every 24 names; and a churchwarden or overseer refusing, shall forfeit 20 l. to the party aggrieved. The

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Poor.

rate is to be levied by distress on those who refuse to pay it; and, by 17 Geo. II. cap. 2. cap. 38. appeals against it are allowed.

If the justices find that the inhabitants of any parish are not able to levy among themselves sufficient sums for the purposes specified in the act, they may assess any other parish within the hundred; and if the hundred be unable to grant necessary relief, they may rate and assess any parish within the county. 43 Eliz. cap. 2.

In order to compel husbands and parents to maintain their own families, the law hath provided, that all persons running away out of their parishes, and leaving their families upon the parish, shall be deemed and suffer as incorrigible rogues (7 Jac. cap. 4.) And if a person merely threatens to run away and leave his wife and children upon the parish, he shall, upon conviction, before one justice by confession, or oath of one witness, be committed to the house of correction for any time not exceeding one month (17 Geo. II. cap. 5.) For the farther maintenance of the poor, there are many fines and forfeitures payable to their use; as for swearing, drunkenness, destroying the game, &c. And also parts of wastes, woods, and pastures, may be inclosed for the growth and preservation of timber and underwood for their relief. See *WORK-HOUSE*.

The famous statute of the 43d of Elizabeth, which is the basis of all the poor-laws in England, was constructed with a cautious forethought that can perhaps be equalled by few laws that ever were enacted; and if prospective reasoning alone were to be relied on in matters of legislation, it seemed impossible to amend it: yet experience has now proved, with a most demonstrative certainty, that it is not so salutary as was undoubtedly expected.

The persons who composed that law had before their eyes such a recent proof of the abuse that had been made of the charitable beneficence of individuals, that they seem to have been chiefly solicitous to obviate similar abuses in future; and to guard against that partial kind of seduction, they rather chose to establish a despotic power which should be authorized to wrest from every individual in the nation whatever sums it might think proper to call for, trusting to a few feeble devices which they contrived, for curbing that power which was virtually armed with force sufficient to set all these aside whenever it pleased. The consequence has been, that the sums levied for the relief of the poor, which were at first but small, are now enormous, and that the demands are increasing in such a rapid manner as to give rise to the most serious and well-grounded apprehensions. In the year 1774, parliament instituted an inquiry into the amount of the poor's-rates in England and Wales, and again in 1783. On comparing these together, the rise during that short period was found to be in England upwards of 850,000 l. *per annum*, being nearly in the proportion of one-third of the rate at the first period. In Wales, during the same period of time, the rates were more than doubled. Nor was this a temporary start, but a part only of a gradual progression. Mr Wenderdon, in his View of England, observes, that "in the year 1680 the poor's-rates produced no more than 665,390 l. in 1764 they stood at 1,200,000 l. and in 1773 they were estimated at 3,000,000 l." It is a known fact (says Mr Beaufoy, in the debate on Mr Gilbert's poor bill, April 17th

1788), that within the last nine years, the poor's-rates have increased one-third, and should they continue increasing in the same proportion for 50 or 53 years, they would amount to the enormous sum of 11,230,000 l. a burden which the country could not possibly bear. It was therefore, he added, highly necessary that something should be attempted to prevent this alarming addition, if not to annihilate the present glaring misconduct in the management of the poor."

Such has been the fate of England with regard to poor laws.

In Scotland, the reformation having been carried forward with a still more violent precipitancy than in England, and the funds of the regular clergy being more entirely alienated, the case of the poor there became still more seemingly desperate, and the clamours were also there considerable at that time. Then also it was that the Scottish court, imitating as usual at that time the practice of England, made several feeble attempts to introduce a system of compulsory poor's-rates into that country, but never digested the system so thoroughly as to form a law that could in any case be carried into effect. Many crude laws on this head were indeed enacted; but all of them so evidently inadequate for the purpose, that they never were, even in one instance that we have heard of, attempted at the time to be carried into effect. Indeed it seems to have been impossible to carry them into effect; for they are all so absurd and contradictory to each other, that hardly a single clause of any one of them can be obeyed without transgressing others of equal importance.

The last statute which in Scotland was enacted on this subject bears date September 1st 1691, William and Mary, parl. 1. sess. 7. chap. 21. and it "ratifies and approves *all* former acts of parliament and proclamations of council for repressing of beggars, and maintaining and employing the poor." If this law therefore were now in force, and it never was repealed, no person could with impunity countervail any one of those statutes which it ratifies; but to be convinced how impossible it is to observe them all, the attentive reader needs only to consider those laws and proclamations with respect to the following particulars, *viz.*

1. *The persons appointed to make up the poor's roll.* By the act 1579 this duty is entrusted to the provost and bailies within burgh, and the judge constitute be the king's commission in paroches to landwart. By act 1663, it is the heritors of each parish. By act 1672, it is the ministers and elders of each parish who are to make up this list. By the proclamation of 1692, it is the heritors, ministers, and elders of every parish. By that of 1693, it is the magistrates of royal burghs, and the heritors of vacant [country] parishes; in both cases without either minister or elders. Among this chaos of contradictions how is it possible to act without transgressing some law.

2. *Not less contradictory are the enactments in regard to the persons who are to pay, and the mode of apportioning the sums among them.* By act 1579, the hail inhabitants of the parochin shall be taxed and stented according to the estimation of their substance, without exception of persons. By that of 1663, the one-half is to be paid by the heritors, and the other half by the tenants and possessors, according to their means and substance. By the proclamation of 1692, the one-half is

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Poor.

Poor.

to be paid by the heritors, the other by the householders of the parish. By that of 1693, in burghs royal, the magistrates are to stent themselves, conform to such order and custom used and wont in laying on stents, annuities, or other public burdens, in the respective burgh, as may be most effectual to reach all the inhabitants; and the heritors of several vacant [landward] parishes to stent themselves for the maintenance of the respective poor.

3. A still greater diversity takes place in regard to the application of the sums so stented. By the act 1570, it would seem that the whole of the money assessed was to be applied to the use of the helpless poor alone, and no part of it for the relief of those who were capable of working. By the act 1663, on the contrary, the whole of this assessment is to be applied for the support of those *only who are able to work*. This is still more specially provided for by the act 1672; where the poor who are unable to work are to be supported by the weekly collections at the kirk doors; and the stented assessments to be applied to the support of those in the correction houses.

It would be tiresome to enumerate all the contradictions that these laws authorise. In regard to the persons who are required to carry these acts into execution, it is at different times the chancellor; magistrates; commissioners of excise; sheriffs; justices of the peace; ministers and elders; the presbyteries; heritors, ministers, and elders; heritors alone; commissioners nominated by presbyteries and appointed by the king; the lords of the privy council: in short, no two laws can be found that do not vary from each other in this respect one way or other.

The same variations take place with regard to the building of correction-houses, confinement and punishment of vagrants, application of their work, awarding their services and those of children. In short, there is not one particular in which these laws do not vary from and contradict each other; so that, let any person try to act in virtue of any one of them, it is impossible for him to avoid going in direct opposition to the enactments of some other law which is of equal force with that he has chosen for his guide. In these circumstances, it is so far from being surprising that these acts have been suffered to remain in perpetual desuetude, that it would have been truly wonderful if this had not been the case. They have, however, been permitted to remain on the statute-book as a disgrace to the times when they were formed, and as a stumbling-block to those that were to follow. That not one of them is now in force was lately proved by a learned and public-spirited gentleman, to whom his country is on that and many other accounts deeply indebted. Refusing to pay the poor's tax, with which he was assessed by the overseers of the parish in which he happened to reside, he stood an action in the court of session, and prevailed, upon the broad ground, *that there is no law in force in Scotland by which an INVOLUNTARY poor's rate can be established in any parish*.

But how, it will be asked by our English readers, are the poor in Scotland really maintained? We answer, by the private alms of individuals, and by certain funds under the management of the *kirk-sessions* (see PRESBYTERIANS). It is the universal practice, each Lord's day, in every parish, for such of the audience as are in

easy circumstances, to give to the poor such an offering of alms as they shall deem proper. This offering is generally dropped into a basin placed at the church-door, and under the immediate care of an elder. When the service is begun, the elder removes with the basin, which he keeps under his charge till the congregation be dismissed. The session then meets, and the money is told over, its amount marked down in the session account book, and deposited in a box kept for that purpose. This box has usually a small slit in the top, through which the pieces of money can be dropped without opening it; and it is closed with two locks, the key of one of which is usually kept by the minister and the other by the kirk-treasurer, so that it can never be opened but in the presence of these two at least.

A kirk-session, when regularly constituted, must always consist of the minister, elders, session-clerk, and kirk-treasurer. None of these ever receive any salary except the session-clerk, who is usually the schoolmaster of the parish, and has a small salary allowed for minuting the transactions. The kirk-treasurer is for the most part one of the elders; and he is an important member of this court. Without his intervention no distribution of the poor's funds is deemed legal; nor can any payments be made, receipts granted, or money transferred, but by him; the minister and session being personally liable to make good all money that may otherwise be given away, should it ever afterwards be challenged by any heritor in the parish.

The precautions taken for the distribution of the poor's funds are likewise simple and excellent, and are as follow.

No money can be legally issued from the poor's funds even by the treasurer and session, unless legal proof can be brought that public intimation has been given from the pulpit immediately after divine service, and before the congregation has dispersed, that a distribution of poor's money is to be made by the session, at such a time and place, specifying the same, and inviting all who have interest in the case to attend if they shall incline. This intimation must be made a full fortnight before the time of distribution; and as every heritor (owner of landed property) in the parish has a right to vote in the distribution of the poor's funds, they may all, if they so incline, then attend and exercise that right: but if none of them should attend, which is often the case, the session has then a right to proceed; and whatever they shall thus do, is deemed strictly legal, and is liable to no challenge. But should they proceed without having given this previous intimation, they may, if the heritors should afterwards challenge it, be made to repay out of their own pockets every shilling they shall have so issued. It sometimes happens, that young ministers, through heedlessness in this respect, expose themselves and families to considerable trouble and loss, which by attention might be easily avoided. In the same way, should a minister and session, without the intervention of a treasurer regularly constituted, lend upon bond or otherwise any of the poor's funds, and should the person so borrowing afterwards fail, these lenders are personally liable to make good the whole, and any heritor in the parish who chooses it can compel him to do so.

The members of the session are also liable to pay all losses, and to account for all sums that it can be instructed

Poor.

Poor.

fructed they received, if they neglect to keep regular books, in which every transaction shall be entered: Or, if these books have not been revised and approved of by the presbytery (A); but if they shall have been so revised, they cannot be challenged for omission of forms, and can only be made to account for errors, or frauds, or evident dilapidations.

Under this wise and economical system of management, it has been found by the experience of more than 200 years, that in the low parts of the country, where the parishes are in general of such moderate extent as to admit of the people of every part of the parish generally to attend divine service every Lord's day, the ordinary funds have been amply sufficient to supply all the real demands of the poor, and in most parishes a fund has been accumulated from the savings of ordinary years to help the deficiencies that may arise in years of uncommon scarcity.

Besides the weekly collections, the extra offerings at the administration of the Lord's supper, the pious donations of charitable individuals, which are all voluntary, together with some small fees paid for the use of a *mort-cloth* (a black velvet pall) at funerals, which is generally purchased with the poor's money, go to make up this parochial fund. Nor must any one believe that the money which comes through the hands of the administrators of the poor's funds is all that is bestowed upon the poor in Scotland; far from it: there are a thousand other channels through which the indigent derive consolation and support, all of them tending to produce the happiest effects upon society. A son feels himself ashamed to think that his parents should require the assistance of another to support them; he therefore strains every nerve when in the vigour of life to spare a little of his earnings to render their old age more easy than it might have been; and sweet to a parent is the bread that is given by the pious attention of a child. If there are several children, they become emulous who shall discover most kindness. It is a pious contention which serves to unite them the closer to each other, by commanding their mutual esteem.

Directly contrary to this is the effect of the poor laws of England, where, in London at least, it is not uncommon to see men in good business neglecting their aged and diseased parents for no better reason than that the parish is bound to find them bread. These laws have other pernicious consequences; for they are obviously subversive of industry as well as morality among the lower orders of the people. "This is a heavy charge, but no less true than heavy. Fear of want is the only effectual motive to industry with the labouring poor: remove that fear, and they cease to be industrious. The ruling passion of those who live by bodily labour, is to save a pittance for their children, and for supporting themselves in old age. Stimulated by desire of accomplishing those ends, they are frugal and indus-

trious: and the prospect of success is a continual feast to them. Now, what worse can malice invent against such a man, under colour of friendship, than to secure bread to him and his children whenever he takes a dislike to work; which effectually deadens his sole ambition, and with it his honest industry? Relying on the certainty of a provision against want, he relaxes gradually till he sinks into idleness; idleness leads to profligacy; profligacy begets diseases; and the wretch becomes an object of public charity before he has run half his course. Wisely therefore is it ordered by Providence, that charity should in every instance be voluntary, to prevent the idle and profligate from depending on it for support. During the reign of Elizabeth, when the monasteries were recently suppressed, and all their revenues squandered, some compulsion might be necessary to prevent the poor from starving. A temporary provision for this purpose, so contrived as not to supersede voluntary charity, but rather to promote it, would have been a measure extremely proper. Unlucky it is for England that such a measure was overlooked; but the queen and her parliaments had not the talent of foreseeing consequences without the aid of experience. A perpetual tax for the poor was imposed, the most pernicious tax, says Lord Kames (B), that ever was imposed in any country."

POPA-MADRE, is a town of South America, in Terra Firma. In this place there is a convent and chapel dedicated to the Virgin Mary, to whose image the Spaniards in those parts go in pilgrimage, particularly those who have been at sea. It is seated on a high mountain, 50 miles east of Carthagena. W. Long. 74-32. N. Lat. 10. 15.

POPE. See VICTIMARIUS.

POPAYAN, a province of South America, in the kingdom of New Granada, between the audience of Panama, that of Quito, and the South Sea; 400 miles in length, and 300 in breadth. A chain of barren mountains runs through the country from north to south; and near the sea the soil is so soaked with almost continual rains, that few care to reside there, except for the sake of the gold that is met with in great plenty in the sands of the rivulets. This bewitching metal brings many in search of it, though it is a great doubt whether they ever return back alive or not. For this reason the savage Americans are still masters of a great part of it, and continually annoy the Spaniards.

POPAYAN, the capital town of a province of that name in South America, with a bishop's see, a Spanish governor, and where the courts of justice are held. The inhabitants are almost all Creoles. It is 220 miles north-east of Quito. W. Long. 75. 55. N. Lat. 2. 35.

POPE, a name which comes from the Greek word *πάππας*, and signifies *Father*. In the east this appellation is given to all Christian priests; and in the west, bishops were called by it in ancient times: but now for many

Papa
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Pope.

(A) The presbytery is by law appointed auditor of the poor's accounts of the several parishes within its bounds; and if they find any difficult case occur in the discharge of this duty, they may lay it before the synod for advice.

(B) See *Sketches of Man*, book ii. sketch 10. where many other arguments equally forcible are urged against all involuntary *poor-rates*, and where many ingenious expedients are proposed for gradually abolishing them where they are established.

Pope.

many centuries it has been appropriated to the bishop of Rome, whom the Roman Catholics look upon as the common father of all Christians.

Much has been said, much written, and many warm disputes have been carried on concerning the pope, and the power belonging to him, within these two or three last centuries. We shall here, without entering into controvery, lay down distinctly, from the best authority, what the Roman Catholics really believe concerning the *pope*, after having described the manner of his election; and we shall give some other particulars relating to this subject that seem to deserve notice, and are in this country not generally known.

All in communion with the see of Rome unanimously hold, that our Saviour Jesus Christ constituted St Peter the apostle chief pastor under himself, to watch over his whole flock here on earth, and to preserve the unity of it; giving him the power requisite for these ends. They also believe, that our Saviour ordained, that St Peter should have successors with the like charge and power, to the end of time. Now, as St Peter resided at Rome for many years, and suffered martyrdom there, they consider the bishops of Rome as his successors in the dignity and office of the universal pastor of the whole Catholic church. There have been some varieties in the manner of choosing the bishop of Rome in different ages, as alterations may be made in discipline; but still the clergy of Rome have justly had the chief part in that election: and that clergy is now represented by, or in some manner consists of, the *cardinals*, who have for several centuries been the sole electors of the pope.

These *cardinals* or *principal persons* of the church of Rome are 70 in number, when the *sacred college*, as it is called, is complete. Of these six are cardinal bishops, the bishops of Ostia, of Porto, Albano, Sabino, Tusculum or Frascati, and Præneste or Palestrina; which are the six suburbicarian churches; fifty are cardinal priests, who have all titles from parish churches in Rome; and fourteen are cardinal deacons, who have their titles from churches in Rome of less note, called *Diaconias* or *Deaconries*. These cardinals are created by the pope when there happen to be vacancies; and sometimes he names one or two only at a time; but commonly he defers the promotion until there be ten or twelve vacancies or more; and then at every second such promotion the emperor, the kings of Spain and France, and of Britain, when Catholic, are allowed to present one each, to be made cardinal, whom the pope always admits if there be not some very great and evident objection. These cardinals are commonly promoted from among such clergymen as have borne offices in the Roman court; some are assumed from religious orders; eminent ecclesiastics of other countries are likewise often honoured with this dignity, as the archbishops of Toledo and Vienna are at present cardinal priests of Rome. Sons of sovereign princes have frequently been members of the sacred college; and there ends the direct line of the royal family of Stuart. Their distinctive dress is scarlet, to signify that they ought to be ready to shed their blood for the faith and church, when the defence and honour of either require it. They wear a scarlet cap and hat: the cap is given to them by the pope if they are at Rome, and is sent to them if they are absent; but the hat is never given but by the pope's own hand. These cardinals form the pope's standing coun-

Pope.

cil or *consistory* for the management of the public affairs of church and state. They are divided into different *congregations* for the more easy dispatch of business; and some of them have the principal offices in the pontifical court, as that of cardinal-vicar—penitentiary—chancellor—camerlingo or chamberlain—prefect of the signature of justice—prefect of memorials—and secretary of state. They have the title given them of *eminence* and *most eminent*. But here we consider them principally as the persons entrusted with the choice of the pope. See *CARDINAL*.

On the demise of a pope his pontifical seal is immediately broken by the chamberlain, and all public business is interrupted that can be delayed: messengers are dispatched to all the Catholic sovereigns to acquaint them of the event, that they may take what measures they think proper; and that the cardinals in their dominions, if any there be, may hasten to the future election if they choose to attend; whilst the whole attention of the sacred college is turned to the preservation of tranquillity in the city and state, and to the necessary preparations for the future election. The cardinal chamberlain has, during the vacancy of the holy see, great authority; he coins money with his own arms on it, lodges in the pope's apartments, and is attended by body-guards. He, and the first cardinal bishop, the first cardinal priest, and the first cardinal deacon, have, during that time, the government almost entirely in their hands. The body of the deceased pope is carried to St Peter's, where funeral service is performed for him with great pomp for nine days, and the cardinals attend there every morning. In the mean time, all necessary preparations for the election are made; and the place where they assemble for that purpose, which is called the *conclave*, is fitted up in that part of the Vatican palace which is nearest to St Peter's church, as this has long been thought the most convenient situation. Here is formed by partitions of wood a number of cells or chambers equal to the number of cardinals, with a small distance between every two, and a broad gallery before them. A number is put on every cell, and small papers with corresponding numbers are put into a box: every cardinal, or some one for him, draws out one of these papers, which determines in what cell he is to lodge. The cells are lined with cloth; and there is a part of each one separated for the conclavists or attendants, of whom two are allowed to each cardinal, and three to cardinal princes. They are persons of some rank, and generally of great confidence; but they must carry in their master's meals, serve him at table, and perform all the offices of a menial servant. Two physicians, two surgeons, an apothecary, and some other necessary officers, are chosen for the conclave by the cardinals.

On the 10th day after the pope's death, the cardinals, who are then at Rome, and in a competent state of health, meet in the chapel of St Peter's, which is called the *Gregorian chapel*, where a sermon on the choice of a pope is preached to them, and mass is said for invoking the grace of the Holy Ghost. Then the cardinals proceed to the conclave in procession two by two, and take up their abode. When all is properly settled, the conclave is shut up, having boxed *wheels* or places of communication in convenient quarters: there are also strong guards placed all around. When any foreign

Pope.

foreign cardinal arrives after the inclosure, the conclave is opened for his admission. In the beginning every cardinal signs a paper, containing an obligation, that if he shall be raised to the papal chair he will not alienate any part of the pontifical dominion; that he will not be prodigal to his relations; and any other such stipulations as may have been settled in former times or framed for that occasion.

We come now to the election itself; and that this may be effectual, two thirds of the cardinals present must vote for the same person. As this is often not easily obtained, they sometimes remain whole months in the conclave. They meet in the chapel twice every day for giving their votes; and the election may be effectuated by *scrutiny*, *acclamation*, or *acclamation*. Scrutiny is the ordinary method; and consists in this: every cardinal writes his own name on the inner part of a piece of paper, and this is folded up and sealed; on a second fold of the same paper a conclavist writes the name of the person for whom his master votes. This, according to agreements observed for some centuries, must be one of the sacred college. On the outer side of the paper is written a sentence at random, which the voter must well remember. Every cardinal, on entering into the chapel, goes to the altar and puts his paper into a large chalice.

When all are convened, two cardinals number the votes; and if there are more or less than the number of cardinals present, the voting must be repeated. When that is not the case, the cardinal appointed for the purpose reads the outer sentence, and the name of the cardinal under it, so that each voter hearing his own sentence and the name joined with it, knows that there is no mistake. The names of all the cardinals that are voted for are taken down in writing, with the number of votes for each; and when it appears that any one has two-thirds of the number present in his favour the election is over: but when this does not happen, the voting papers are all immediately burnt without opening up the inner part. When several trials of coming to a conclusion by this method of *scrutiny* have been made in vain, recourse is sometimes had to what is called *acclamation*. By it, when a cardinal perceives that one or very few votes are wanting to any one for whom he had not voted at that time, he may say that he *accedes* to the one who has near the number of votes requisite; and if his one vote suffices to make up the two-thirds, or if he is followed by a sufficient number of *acceders* or new voters for the said cardinal, the election is accomplished. Lastly, a pope is sometimes elected by *acclamation*; and that is, when a cardinal, being pretty sure that he will be joined by a number sufficient, cries out in the open chapel, that such an one shall be pope. If he is supported properly, the election becomes unanimous; those who would perhaps oppose it foreseeing that their opposition would be fruitless, and rather hurtful to themselves. It is to be observed, that the emperor of Germany and the kings of France and Spain claim a right of excluding one cardinal from being pope at every election. Hence, when the ambassador at Rome of any of these sovereigns perceives that any cardinal, disagreeable to his master, according to the instructions he has received, is like to be made pope, he demands an audience of the conclave, is admitted, and there declares his master's will, which is always attended to for

Vol. XV. Part I.

the common good. But each of those sovereigns is allowed thus to exclude only one at one time; and they unwillingly and seldom put this right in execution.

Pope.

When a pope is chosen in any of the three above-mentioned ways, the election is immediately announced from the balcony in the front of St Peter's, homage is paid to the new pontiff, and couriers are sent off with the news to all parts of Christendom. The pope appoints a day for his coronation at St Peter's, and for his taking possession of the patriarchal church of St John Lateran; all which is performed with great solemnity. He is addressed by the expression of *Holiness*, and *most holy Father*.

Let us now proceed to see what authority Roman Catholics attribute to the pope thus chosen. They believe, then, that the bishop of Rome is, under Christ, supreme pastor of the whole church; and as such is not only the first bishop in order and dignity, but has also a power and jurisdiction over all Christians, in order to preserve unity and purity of faith and moral doctrine, and to maintain order and regularity in all churches. Wherefore they hold, that when the pope understands that any error has been broached against faith or manners, or that any considerable difference on such subjects has arisen in any part of Christendom, it belongs to him, after due deliberation and consultation, to issue out his pastoral decree, condemning the error, clearing up the doubt, and declaring what has been delivered down, and what is to be believed. Some Catholic divines are of opinion that the pope cannot err, when he thus addresses himself to *all the faithful* on matters of doctrine. They well know, that as a private doctor he may fall into mistakes as well as any other man; but they think, that when he teaches the whole church Providence must preserve him from error; and they apprehend, that this may be deduced from the promises of Christ to St Peter, and from the writings of the ancient fathers. However, this infallibility of the pope, even when he pronounces in the most solemn manner, is only an opinion, and not an article of Roman Catholic faith. Wherefore, when he sends for the doctrinal decrees, the other bishops, who are also guardians of the faith in an inferior degree, may, with due respect, examine these decrees; and if they see them agree with what has been always taught, they either formally signify their acceptance, or they tacitly acquiesce, which, considering their duty, is equivalent to a formal approbation. When the acceptance of the generality of the bishops has been obtained, either immediately or after some mutual correspondence and explanation, the decrees of the pope thus accepted come to be the sentence of the whole church, and are believed to be beyond the possibility of error!

Sometimes it may happen that the disputes and difference may be so great and intricate, that to the end it may be seen more clearly what has really been delivered down; and to give all possible satisfaction, it may appear proper to convene all the bishops who can conveniently attend to one place, to learn from them more distinctly what has been taught and held in their respective churches. Roman Catholics believe that it belongs to the pope to call such general councils, and to preside in them in person or by his legates. They likewise hold, that when the pope has approved the decrees of such councils concerning faith or manners,

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such

Pope.

Pope.

such decrees are then final, and must be received as such by all Catholics. In all this they believe, that the particular assistance of the Holy Ghost is with the pastors of the church, that so *the gates of hell may never prevail against her.*

The see of Rome, according to Roman Catholics, is the centre of Catholic unity. All their bishops communicate with the pope, and by his means with one another, and so form one body. However distant their particular churches may be, they all meet at Rome either in person or by their delegates, or at least by their letters. And, according to the discipline of the latter ages, though they are presented to the pope for their office from their respective countries, yet from him they must receive their bulls of consecration before they can take possession of their sees.

In matters of church discipline, the pope, as chief pastor, not only ought to take care that the canons actually in force be observed in all churches, but he may also make new canons and regulations when he sees it necessary or expedient for the spiritual benefit of the faithful, according to times and circumstances. But in doing this he must not infringe the established rights or customs with injury to any person; which if, through mistake or wrong information, he should ever do, the persons who think themselves aggrieved may remonstrate with respect and sue for redress. He may establish new episcopal sees, where there have been none before; and he may alter the limits of former dioceses; but in such alterations he always of course consults the temporal sovereign, if in communion with him. He sends pastors to preach the gospel to all countries where the Catholic religion is not by law established; and to him appeals may be made from all parts of Christendom in ecclesiastical causes of great importance.

The pope may dispense with the observance of ecclesiastical canons when there are just reasons for it, as may frequently happen; he may also dispense with vows when they are made with that express or tacit condition (A) that he really may dispense with them; he may also on some occasions declare that obligations have really ceased when that is truly the case, from a great alteration of circumstances: But he can never grant any dispensation, to the injury of any third person, and can never allow any one to do what is unjust, or to say what he knows to be false, whatever advantage might be expected from it.

The pope is also a temporal prince, and possesses considerable dominions in the middle part of Italy, besides Avignon, which the French have lately taken from him, and the duchy of Benevento inclosed within the kingdom of Naples. It is also supposed that the kingdoms of Naples and Sicily, and the duchies of Parma and Placentia, are still held of him in fief as they were before. His predecessors have acquired these possessions at different times and on different occasions, by various donations, concessions, treaties, and agreements, in like manner as has happened with regard to the establishment of other sovereignties; and his title to them is like to that of other potentates to their respective possessions. The revenue arising from this estate, and

what he receives for various reasons from Catholic countries, which is now much reduced, is employed for the support of government, in salaries to the officers of his court, for the education of clergymen, and for the maintaining of missionaries in infidel countries. Great sums are particularly expended for the propagation of the Christian faith in different parts of Asia, especially in Armenia, Syria, and China. Nor is it much to be wondered at, if the families, of which the sovereign pontiffs happen to have been born, acquire greater riches and splendor from that connection. The princely families of Barberini, Borghese, Chigi, Corsini, Albani, are examples of this kind: but regulations have been made in later times to prevent excessive nepotism. Beyond the limits of his own temporal dominions the pope has no temporal power or jurisdiction, excepting what any nation may be pleased to allow him: when any thing of that kind has been granted or brought in by custom, it is evident that it ought not to be taken away rashly nor without just reason. But, as chief pastor of the church, he has no right to any temporal jurisdiction over his flock. As such, his power is entirely spiritual, and has no means of coercion originally or necessarily connected with it, but only ecclesiastical censures. It must be owned, that the popes, in some ages, sometimes imagining that they could do much good, sometimes by the consent, or even at the desire, of the sovereigns, and sometimes no doubt out of ambitious views, have interfered a great deal in the temporal affairs of the different kingdoms of Europe, which has frequently given scandal and done harm to religion. But it is known to those most versant in history, that their faults of this kind have been exaggerated, and their conduct often misunderstood or misrepresented. However, in this a Roman Catholic is not obliged to approve what they have done; nay, without acting contrary to his religion, he may judge of them freely, and blame them if he think they deserve it; only he will do it with respect and regret. Thus a Roman Catholic may either apologise, if he think he can do it, for the conduct of Innocent III. in deposing king John of England; or, without being guilty of any offence against his religion, he may blame the pontiff for what he did on that occasion; because the power of the pope to depose princes, or to absolve subjects from their allegiance, was never proposed as an article of faith, or made a term of communion with the church of Rome. Some Catholic divines, indeed, especially among the Jesuits, are universally known to have held this extravagant and dangerous opinion; but by far the greater part of them condemn and abhor it as absurd and impious: and surely it is but fair and just to allow them to know best what they themselves believe. And here, to conclude, we shall add, that it is very desirable that Christians of all denominations endeavour to understand one another better than they have often done; and instead of supposing imaginary differences, strive to remove real ones, for the general good of mankind, for the glory of God, and honour of religion; and that all vie with one another to excel in just and charitable sentiments, language, and behaviour.

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(A) Any other man may unquestionably do the same when they are made with that express condition.

Pope.

The reader, who wishes to know what can be urged for and against the supremacy of the pope, and who is fitted by his knowledge of ecclesiastical history to understand the nature of the question at issue, may consult, on the one hand, the works of Bellarmine, together with a small tract lately published in English, under the title of *The Divine Economy of Christ in his Kingdom or Church*; and on the other, Barrow's treatise on the *Pope's Supremacy*, together with Chillingworth's *Religion of Protestants*, &c.

POPE (Alexander), a celebrated English poet, was descended from good families, and born the 8th of June 1688, at London, where his father was then a considerable merchant. He was taught to read very early by an aunt; and learned to write without any assistance, by copying printed books. The family being of the Romish religion, he was put, at eight years of age, under one Taverner, a priest, who taught him the rudiments of the Latin and Greek tongues together; and soon after was sent to a Popish seminary at Winchester, from whence he was removed to a school at Hyde-Park Corner. He discovered early an inclination to versifying; and the translations of Ogilby and Sandys from Virgil and Ovid first falling in his way, they were his favourite authors. At twelve he retired with his parents to Binfield, in Windsor Forest; and there became acquainted with the writings of Spenser, Waller, and Dryden. Dryden struck him most, probably because the cast of that poet was most congenial with his own; and therefore he not only studied his works intensely, but ever after mentioned him with a kind of rapturous veneration. He once obtained a sight of him at a coffee-house, but never was known to him: a misfortune which he laments in these short but expressive words, *Virgilium tantum vidi*. Though Pope had been under more tutors than one, yet it seems they were so insufficient for the purpose of teaching, that he had learned very little from them: so that, being obliged afterwards to begin all over again, he may justly be considered as one of the *αὐτοδίδακτοι* or *self-taught*. At fifteen he had acquired a readiness in the two learned languages; to which he soon after added the French and Italian. He had already scribbled a great deal of poetry in various ways; and this year set about an epic poem called *Alcander*. He long after communicated it to Atterbury, with a declared intention to burn it; and that friend concurred with him: "Though (adds he) I would have interceded for the first page, and put it, with your leave, among my curiosities." What the poet himself observes upon these early pieces is agreeable enough; and shows, that though at first a little intoxicated with the waters of Helicon, he afterwards arrived to great sobriety of thinking. "I confess (says he) there was a time when I was in love with myself; and my first productions were the children of Self-love upon Innocence. I had made an epic poem, and panegyrics on all the princes; and I thought myself the greatest genius that ever was. I cannot but regret these delightful visions of my childhood, which, like the fine colours we see when our eyes are shut, are vanished for ever." His pastorals, begun in 1704, first introduced him to the wits of the time; among which were Wycherly and Walfsh. This last gentleman proved a sincere friend to him; and soon discerning that his talent lay, not so much in striking out new thoughts of his own, as in

improving those of other men, and in an easy verification, told him, among other things, that there was one way left open for him to excel his predecessors in, which was correctness: observing, that though we had several great poets, yet none of them were correct. Pope took the hint, and turned it to good account; for no doubt the distinguishing harmony of his numbers was in a great measure owing to it. The same year, 1704, he wrote the first part of his *Windsor Forest*, though the whole was not published till 1710. In 1708, he wrote the *Essay on Criticism*: which production was justly esteemed a masterpiece in its kind, and showed not only the peculiar turn of his talents, but that those talents, young as he was, were ripened into perfection. He was not yet twenty years old; and yet the maturity of judgment, the knowledge of the world, and the penetration into human nature, displayed in that piece, were such as would have done honour to the greatest abilities and experience. But whatever may be the merit of the *Essay on Criticism*, it was still surpassed, in a poetical view, by the *Rape of the Lock*, first completely published in 1712. The former excelled in the didactic way, for which he was peculiarly formed; a clear head, strong sense, and a sound judgment, being his characteristic qualities; but it is the creative power of the imagination that constitutes what is properly called a poet; and therefore it is in the *Rape of the Lock* that Pope principally appears one, there being more *vis imaginandi* displayed in this poem than perhaps in all his other works put together. In 1713, he gave out proposals for publishing a translation of Homer's *Iliad*, by subscription; in which all parties concurred so heartily, that he acquired a considerable fortune by it. The subscription amounted to 6000 l. besides 1200 l. which Lintot the bookseller gave him for the copy. Pope's finances being now in good condition, he purchased a house at Twickenham, whither he removed with his father and mother in 1715: where the former died about two years after. As he was a Papist, he could not purchase, nor put his money to interest on real security; and as he adhered to the cause of King James, he made it a point of conscience not to lend it to the new government; so that, though he was worth near 20,000 l. when he laid aside business, yet, living afterwards upon the quick stock, he left but a slender subsistence to his family. Our poet, however, did not fail to improve it to the utmost: he had already acquired much by his publications, and he was all attention to acquire more. In 1717, he published a collection of all he had printed separately; and proceeded to give a new edition of Shakespeare; which, being published in 1721, discovered that he had consulted his fortune more than his fame in that undertaking. The *Iliad* being finished, he engaged upon the like footing to undertake the *Odyssey*. Mr Broome and Mr Fenton did part of it, and received 500 l. of Mr Pope for their labours. It was published in the same manner, and on the same conditions to Lintot; excepting that, instead of 1200 l. he had but 600 l. for the copy. This work being finished in 1725, he was afterwards employed with Swift and Arbuthnot in printing some volumes of *Miscellanies*. About this time he narrowly escaped losing his life, as he was returning home in a friend's chariot; which, on passing a bridge, happened to be overturned, and thrown with the horses into the river.

Pope.

Pope.

The glasses were up, and he was not able to break them : so that he had immediately been drowned, if the position had not broke them, and dragged him out to the bank. A fragment of the glass, however, cut him so desperately, that he ever after lost the use of two of his fingers. In 1727 his *Dunciad* appeared in Ireland; and the year after in England, with notes by Swift, under the name of *Scriblerus*. This edition was presented to the king and queen by Sir Robert Walpole; who, probably about this time, offered to procure Pope a pension, which however he refused, as he had formerly done a proposal of the same kind made him by Lord Halifax. He greatly cultivated the spirit of independency; and "Unplac'd, unpension'd, no man's heir or slave," was frequently his boast. He somewhere observes, that the life of an author is a state of warfare: he has shown himself a complete general in this way of warring. He bore the insults and injuries of his enemies long; but at length, in the *Dunciad*, made an absolutely universal slaughter of them: for even Cibber, who was afterwards advanced to be the hero of it, could not forbear owning, that nothing was ever more perfect and finished in its kind than this poem. In 1729, by the advice of Lord Bolingbroke, he turned his pen to subjects of morality; and accordingly we find him, with the assistance of that noble friend, who furnished him with the materials, at work this year upon the *Essay on Man*. The following extract of a letter to Swift discovers the reason of his Lordship's advice: "Bid him (says Bolingbroke) talk to you of the work he is about, I hope in good earnest; it is a fine one, and will be, in his hands, an original. His sole complaint is, that he finds it too easy in the execution. This flatters his laziness: it flatters my judgement; who always thought, that, universal as his talents are, this is eminently and peculiarly his, above all the writers I know, living or dead; I do not except Horace." Pope tells the dean in the next letter, that "the work Lord Bolingbroke speaks of with such abundant partiality, is a system of ethics, in the Horatian way." In pursuing the same design, he wrote his *Ethic Epistles*: the fourth of which, upon Taste, giving great offence, as he was supposed to ridicule the duke of Chandos under the character of Timon, is said to have put him upon writing satires, which he continued till 1739. He ventured to attack persons of the highest rank, and set no bounds to his satirical rage. A genuine collection of his letters was published in 1737. In 1738, a French translation of the *Essay on Man*, by the Abbé Refnel, was printed at Paris; and Mr Croufaz, a German professor, animadverted upon this system of ethics, which he represented as nothing else but a system of naturalism. Mr Warburton, afterwards bishop of Gloucester, wrote a commentary upon the *Essay*; in which he defends it against Croufaz, whose objections he supposes owing to the faultiness of the Abbé Refnel's translation. The poem was republished in 1740, with the commentary. Our author now added a fourth book to the *Dunciad*, which was first printed separately in 1742: but the year after, the whole poem came out together, as a specimen of a more correct edition of his works. He had made some progress in that design, but did not live to complete it. He had all his life long been subject to the head-ach; and that complaint, which he derived from

Pope.

his mother, was now greatly increased by a dropfy in his breast, under which he expired the 30th of May 1744, in the 56th year of his age. In his will, dated December 12. 1743, Miss Blount, a lady to whom he was always devoted, was made his heir during her life: and among other legacies, he bequeathed to Mr Warburton the property of all such of his works, already printed, as he had written, or should write commentaries upon, and which had not otherwise been disposed of or alienated; with this condition, that they were published without future alterations. In discharge of this trust, that gentleman gave a complete edition of all Mr Pope's works, 1751, in 9 vols, 8vo. A work, entitled, *An Essay on the Writings and Genius of Pope*, by Mr Warton, 2 vols 8vo, will be read with pleasure by those who desire to know more of the person, character, and writings of this excellent poet. Lord Orrery's account of him is very flattering: "If we may judge of him by his works (says this noble author), his chief aim was to be esteemed a man of virtue. His letters are written in that style; his last volumes are all of the moral kind; he has avoided trifles, and consequently has escaped a rock which has proved very injurious to Swift's reputation. He has given his imagination full scope, and yet has preserved a perpetual guard upon his conduct. The constitution of his body and mind might really incline him to the habits of caution and reserve. The treatment which he met with afterwards, from an innumerable tribe of adversaries, confirmed this habit; and made him slower than the dean in pronouncing his judgment upon persons and things. His prose-writings are little less harmonious than his verse; and his voice, in common conversation, was so naturally musical, that I remember honest Tom Southern used to call him the *little nightingale*. His manners were delicate, easy, and engaging; and he treated his friends with a politeness that charmed, and a generosity that was much to his honour. Every guest was made happy within his doors; pleasure dwelt under his roof, and elegance presided at his table."

Yet, from Dr Johnson's account of his domestic habits, we have reason to doubt the latter part of this character. His parsimony (he informs us) appeared in very petty matters, such as writing his compositions on the backs of letters, or in a niggardly reception of his friends, and a scantiness of entertainment—as the setting a single pint on the table to two friends, when, having himself taken two small glasses, he would retire, saying, I leave you to your wine. He sometimes, however, the Doctor acknowledges, made a splendid dinner; but this happened seldom. He was very full of his fortune, and frequently ridiculed poverty; and he seems to have been of an opinion not very uncommon in the world, that to want money is to want every thing. He was almost equally proud of his connection with the great, and often boasted that he obtained their notice by no meanness or servility. This admiration of the great increased in the advance of life; yet we must acknowledge, that he could derive but little honour from the notice of Cobham, Burlington, or Bolingbroke.

By natural deformity, or accidental distortion, his vital functions were so much disordered, that his life was a long disease; and from this cause arose many of his peculiarities and weaknesses. He stood constantly

Pope.

in need of female attendance; and to avoid cold, of which he was very sensible, he wore a fur doublet under his shirt, &c. The indulgence and accommodation which his sickness required, had taught him all the unpleasing and unsocial qualities of a valetudinary man.—When he wanted to sleep, he nodded in company; and once slumbered at his own table when the prince of Wales was talking of poetry. He was extremely troublesome to such of his friends as asked him out, which many of them frequently did, and plagued the servants beyond description. His love of eating is another fault to which he is said to have fallen a sacrifice. In all his intercourse with mankind, he had great delight in artifice, and endeavoured to attain all his purposes by indirect and unsuspected methods.

In familiar conversation it is said he never excelled; and he was so fretful and so easily displeased, that he would sometimes leave Lord Oxford's silently without any apparent reason, and was to be courted back by more letters and messages than the servants were willing to carry.

Dr Johnson also gives a view of the intellectual character of Pope, and draws a parallel between Dryden and him. For particulars, however, we must refer our readers to *Johnson's Lives of the Poets*.

POPE'S DOMINIONS, or *Ecclesiastical States*, a country of Italy, bounded on the north by the gulph of Venice and the Venetian dominions, on the south by the Mediterranean, on the east by the kingdom of Naples and the Adriatic, and on the west by Tuscany and Modena. It is 400 miles long on the coast of the Adriatic from Naples to the Venetian territory. It is but narrow, however, from north to south, not being more than 80 miles broad from the gulph of Venice to the Tuscan sea.

The soil, in general, of the pope's dominions is very fertile, but ill cultivated; and there are many fens and marshy grounds which are very prejudicial to the air. That the lands are badly cultivated and inhabited, the air bad, and the inhabitants poor, idle, lazy, and grossly superstitious, is owing to a variety of causes. With respect to the accommodations of life, this country is but in a very indifferent condition; for, notwithstanding the fertility of its soil, its advantageous situation for traffic, the large sums spent in it by travellers, or remitted to it from foreign countries, and its having, for its ruler, the successor of St Peter, the prince of the apostles, and the vicar of Jesus Christ; yet it is poor and thin of inhabitants, ill cultivated, and without trade and manufactures. This is partly owing to the great number of holidays, of sturdy beggars called *pilgrims*, and of hospitals and convents, with the amazing but perhaps useless wealth of churches and convents, and the inquisition: but the chief cause is the severity of the government, and the grievous exactions and hardships to which the subjects are exposed. The legates, though mostly clergymen, whose thoughts should be chiefly employed about laying up treasures in heaven, and who ought to set an example to the laity of disinterestedness and a contempt of this world, too often, it is said, scruple no kind of rapaciousness: even the holy father himself, and the cardinals, frequently make the enriching of their nephews and other relations, and the aggraundizing their families, too much the business of their lives. The extensive claims and great pretensions of the pope are well

known, and by a large part of Christendom, are now treated with contempt and mockery. The Reformation gave a great blow to his spiritual power; and the French revolution has lessened it still more. His temporal dominions, however, still continue much the same; though how long this may be the case, considering how much he hath lost, and is daily losing, of his ghostly empire, and the veneration in which he was formerly held, it is difficult to say. See *POPE*, p. 378. col. 1.—The Campania of Rome is under the pope's immediate government; but the other provinces are governed by legates and vice-legates, and there is a commander in chief of the pope's forces in every province. The pope is chosen by the cardinals in the conclave: See this particularly described under *POPE*. The pope holds a consistory of cardinals on ecclesiastical affairs; but the cardinals do not meddle with his civil government. The pope's chief minister is the cardinal-patron, usually his nephew, who amasses an immense estate, if the reign be of any long duration. The cardinal that is chosen pope must generally be an Italian, and at least 55 years of age. The spiritual power of the pope, though far short of what it was before the Reformation, is still considerable. It is computed that the monks and regular clergy, who are absolutely at his devotion, do not amount to less than 2,000,000 of people, dispersed through all the Roman Catholic countries, to assert his supremacy over princes, and promote the interest of the church. The revenues of these monks do not fall short of L. 20,000,000 Sterling, besides the casual profits arising from offerings, and the people's bounty to the church, who are taught that their salvation depends on this kind of benevolence.

The pope's revenues, as a temporal prince, may amount to about L. 1,000,000 Sterling *per annum*, arising chiefly from the monopoly of corn, the duties on wine and other provisions. Over and above these, vast sums are continually flowing into the papal treasury from all the Roman Catholic countries, for dispensations, indulgences, canonizations, annates, the pallia, and investitures of archbishops, bishops, &c.

The pope has a considerable body of regular forces, well clothed and paid; but his fleet consists only of a few galleys. His life-guards are 40 Switzers, 75 cuirassiers, and as many light horse. Since the beginning of this war, we are told, he has likewise had a guard of English horse.

POPERY, in ecclesiastical history, comprehends the religious doctrines and practices adopted and maintained by the church of Rome. The following summary, extracted chiefly from the decrees of the council of Trent, continued under Paul III. Julius III. and Pius IV. from the year 1545 to 1563, by successive sessions, and the creed of pope Pius IV. subjoined to it, and bearing date November 1564, may not be unacceptable to the reader. One of the fundamental tenets, strenuously maintained by popish writers, is the infallibility of the church of Rome; though they are not agreed whether this privilege belongs to the pope or a general council, or to both united; but they pretend that an infallible living judge is absolutely necessary to determine controversies, and to secure peace in the Christian church. However, Protestants allege, that the claim of infallibility in any church is not justified

by

Popery. by the authority of Scripture; much less does it pertain to the church of Rome; and that it is inconsistent with the nature of religion, and the personal obligations of its professors; and that it has proved ineffectual to the end for which it is supposed to be granted, since popes and councils have disagreed in matters of importance, and they have been incapable, with the advantage of this pretended infallibility, of maintaining union and peace.

Another essential article of the popish creed is the supremacy of the pope, or his sovereign power over the universal church. See **POPE**.

Farther, the doctrine of the seven sacraments is a peculiar and distinguishing doctrine of the church of Rome: these are baptism, confirmation, the eucharist, penance, extreme unction, orders, and matrimony.

The council of Trent (sess. 7. can. 1.) pronounces an anathema on those who say, that the sacraments are more or fewer than seven, or that any one of the above number is not truly and properly a sacrament. And yet it does not appear that they amounted to this number before the 12th century, when Hugo de St Victor and Peter Lombard, about the year 1144, taught that there were seven sacraments. The council of Florence, held in 1438, was the first council that determined this number. These sacraments confer grace, according to the decree of the council of Trent (sess. 7. can. 8.) *ex opere operato*, by the mere administration of them: three of them, viz. baptism, confirmation, and orders, are said (can. 9.) to impress an indelible character, so that they cannot be repeated without sacrilege; and the efficacy of every sacrament depends on the intention of the priest by whom it is administered (can. 11.) Pope Pius expressly enjoins, that all these sacraments should be administered according to the received and approved rites of the Catholic church. With regard to the eucharist in particular, we may here observe, that the church of Rome holds the doctrine of transubstantiation; the necessity of paying divine worship to Christ under the form of the consecrated bread, or host; the propitiatory sacrifice of the mass, according to their ideas of which Christ is truly and properly offered as a sacrifice as often as the priest says mass; it practises likewise solitary mass, in which the priest alone, who consecrates, communicates, and allows communion only in one kind, viz. the bread, to the laity. Sess. 14.

The doctrine of merits is another distinguishing tenet of popery; with regard to which the council of Trent has expressly decreed (sess. 6. can. 32.) that the good works of justified persons are truly meritorious; deserving not only an increase of grace, but eternal life, and an increase of glory; and it has anathematized all who deny this doctrine. Of the same kind is the doctrine of satisfactions; which supposes that penitents may truly satisfy, by the afflictions they endure under the dispensations of Providence, or by voluntary penances to which they submit, for the temporal penalties of sin, to which they are subject, even after the remission of their eternal punishment. Sess. 6. can. 30. and sess. 14. can. 8. and 9. In this connection we may mention the popish distinction of venial and mortal sins: the greatest evils arising from the former are the temporary pains of purgatory; but no man, it is said, can obtain the pardon of the latter without

confessing to a priest, and performing the penances which he imposes. **Popery.**

The council of Trent (sess. 14. can. 1.) has expressly decreed, that every one is accursed, who shall affirm that penance is not truly and properly a sacrament, instituted by Christ in the universal church, for reconciling those Christians to the divine majesty, who have fallen into sin after baptism: and this sacrament, it is declared, consists of two parts, the matter and the form; the matter is the act of the penitent, including contrition, confession, and satisfaction; the form of it is the act of absolution on the part of the priest. Accordingly it is enjoined, that it is the duty of every man, who hath fallen after baptism, to confess his sins once a year, at least, to a priest: that this confession is to be secret; for public confession is neither commanded nor expedient: and that it must be exact and particular, including every kind and act of sin, with all the circumstances attending it. When the penitent has so done, the priest pronounces an absolution; which is not conditional or declarative only, but absolute and judicial. This secret, or auricular confession, was first decreed and established in the fourth council of Lateran, under Innocent III. in 1215, (cap. 21.) And the decree of this council was afterwards confirmed and enlarged in the council of Florence, and in that of Trent; which ordains, that confession was instituted by Christ, that by the law of God it is necessary to salvation, and that it has been always practised in the Christian church. As for the penances imposed on the penitent by way of satisfaction, they have been commonly the repetition of certain forms of devotion, as pater-nosters, or ave-marias, the payment of stipulated sums, pilgrimages, fasts, or various species of corporal discipline. But the most formidable penance, in the estimation of many who have belonged to the Romish communion, has been the temporary pains of purgatory. But under all the penalties which are inflicted or threatened in the Romish church, it has provided relief by its indulgences, and by its prayers or masses for the dead, performed professedly for relieving and rescuing the souls that are detained in purgatory.

Another article that has been long authoritatively enjoined and observed in the church of Rome, is the celibacy of her clergy. This was first enjoined at Rome by Gregory VII. about the year 1074, and established in England by Anselm archbishop of Canterbury about the year 1175; though his predecessor Lanfranc had imposed it upon the prebendaries and clergy that lived in towns. And though the council of Trent was repeatedly petitioned by several princes and states to abolish this restraint, the obligation of celibacy was rather established than relaxed by this council; for they decreed, that marriage contracted after a vow of continence, is neither lawful nor valid; and thus deprived the church of the possibility of ever restoring marriage to the clergy. For if marriage, after a vow, be in itself unlawful, the greatest authority upon earth cannot dispense with it, nor permit marriage to the clergy, who have already vowed continence.

To the doctrines and practices above recited may be farther added the worship of images, of which Protestants accuse the Papists. But to this accusation the Papist replies, that he keeps images by him to preserve

Popery.

Papist Mis-
represented
and Repre-
sented.

in his mind the memory of the persons represented by them; as people are wont to preserve the memory of their deceased friends by keeping their pictures. He is taught (he says) to use them so as to cast his eyes upon the pictures or images, and thence to raise his heart to the things represented, and there to employ it in meditation, love, and thanksgiving, desire of imitation, &c. as the object requires.

These pictures or images have this advantage, that they inform the mind by one glance of what in reading might require a whole chapter. There being no other difference between them, than that reading represents leisurely and by degrees; and a picture, all at once. Hence he finds a convenience in saying his prayers with some devout pictures before him, he being no sooner distracted, but the sight of these recalls his wandering thoughts to the right object; and as certainly brings something good into his mind, as an immodest picture disturbs his heart with filthy thoughts. And because he is sensible that these holy pictures and images represent and bring to his mind such objects as in his heart he loves, honours, and venerates; he cannot but upon that account love, honour, and respect, the images themselves.

222.

The council of Trent likewise decreed, that all bishops and pastors who have the cure of souls, do diligently instruct their flocks, *that it is good and profitable to desire the intercession of saints reigning with Christ in heaven.* And this decree the Papists endeavour to defend by the following observations. They confess that we have but one Mediator of redemption; but affirm that it is acceptable to God that we should have many mediators of intercession. Moses (say they) was such a mediator for the Israelites; Job for his three friends; Stephen for his persecutors. The Romans were thus desired by St Paul to be his mediators; so were the Corinthians, so the Ephesians, *Ep. ad Rom. Cor. Eph.* so almost every sick man desires the congregation to be his mediators, by remembering him in their prayers. And so the Papist desires the blessed in heaven to be his mediators; that is, that they would pray to God for him. But between these living and dead mediators there is no similarity: the living mediator is present, and certainly hears the request of those who desire him to intercede for them; the dead mediator is as certainly absent, and cannot possibly hear the requests of all those who at the same instant may be begging him to intercede for them, unless he be possessed of the divine attribute of omnipresence; and he who gives that attribute to any creature is unquestionably guilty of idolatry. And as this decree is contrary to one of the first principles of natural religion, so does it receive no countenance from Scripture, or any Christian writer of the three first centuries. Other practices peculiar to the Papists are the religious honour and respect that they pay to sacred relics; by which they understand not only the bodies and parts of the bodies of the saints, but any of those things that appertained to them, and which they touched; and the celebration of divine service in an unknown tongue: to which purpose the council of Trent hath denounced an anathema on any one who shall say that mass ought to be celebrated only in the vulgar tongue; sess. 25. and sess. 22. can. 9. Though the council of Lateran under Innocent III. in 1215 (can. 9.) had expressly decreed, that because in many

parts within the same city and diocese there are many people of different manners and rites mixed together, but of one faith, the bishops of such cities or dioceses should provide fit men for celebrating divine offices, according to the diversity of tongues and rites, and for administering the sacraments.

Popery,
Popham.

We shall only add, that the church of Rome maintains, that unwritten traditions ought to be added to the holy Scriptures, in order to supply their defect, and to be regarded as of equal authority; that the books of the Apocrypha are canonical scripture; that the vulgate edition of the Bible is to be deemed authentic; and that the Scriptures are to be received and interpreted according to that sense which the holy mother church, to whom it belongs to judge of the true sense, hath held, and doth hold, and according to the unanimous consent of the fathers,

Such are the principal and distinguishing doctrines of Popery, most of which have received the sanction of the council of Trent, and that of the creed of pope Pius IV. which is received, professed, and sworn to by every one who enters into holy orders in the church of Rome; and at the close of this creed, we are told that the faith contained in it is so absolutely and indispensably necessary, that no man can be saved without it.

Many of the doctrines of Popery were relaxed, and very favourably interpreted by M. de Meaux, bishop of Condom, in his Exposition of the Doctrine of the Catholic Church, first printed in the year 1671: but this edition, which was charged with perverting, in endeavouring to palliate, the doctrine of the church, was censured by the doctors of the Sorbonne, and actually suppressed; nor does it appear that they ever testified their approbation in the usual form of subsequent and altered editions. It has, however, been lately published in this country, by a clergyman of the Romish church, whose integrity, piety, and benevolence, would do honour to any communion.

POPHAM (Sir John), lord chief justice of the common pleas in the reign of Queen Elizabeth, was the eldest son of Edward Popham, Esq; of Huntworth in Somersetshire, and born in the year 1531. He was some time a student of Baliol college in Oxford; "being then (says Ant. Wood) given at leisure hours to many sports and exercises." After quitting the university, he fixed in the Middle Temple; where, during his novitiate, he is said to have indulged in that kind of dissipation to which youth and a vigorous constitution more naturally incline than to the study of voluminous reports: but, satiated at length with what are called the pleasures of the town, he applied sedulously to the study of his profession, was called to the bar, and in 1568 became summer or autumn reader. He was soon after made serjeant at law, and solicitor-general in 1579. In 1581, he was appointed attorney-general, and treasurer of the Middle Temple. In 1592, he was made lord chief justice of the king's bench, and the same year received the honour of knighthood. In the year 1601, his lordship was one of the council detained by the unfortunate earl of Essex, when he formed the ridiculous project of defending himself in his house: and, on the earl's trial, he gave evidence against him relative to their detention. He died in the year 1607, aged 76; and was buried in

Poplar
||
Populus.

in the south aisle of the church at Wellington in Somersetshire, where he generally resided as often as it was in his power to retire. He was thought somewhat severe in the execution of the law against capital offenders: but his severity had the happy effect of reducing the number of highway robbers. He wrote, 1. Reports and cases adjudged in the time of Queen Elizabeth. 2. Resolutions and judgments upon cases and matters agitated in all the courts at Westminster in the latter end of Queen Elizabeth's reign.

POPLAR, in botany. See *POPULUS*.

POPLITÆUS, in anatomy, a small muscle obliquely pyramidal, situated under the ham. See *ANATOMY*, *Table of the Muscles*.

POPPY, in botany. See *OPIMUM* and *PAPAYER*.

POPULAR, something that relates to the common people.

POPULATION, means the state of a country with respect to the number of people. See *Bills of MORTALITY* and *POLITICAL-Arithmetic*.

The question concerning the number of men existing upon earth, has been variously determined by different writers. Riccioli states the population of the globe at 1000 millions, Vossius at 500; the Journalists of Trevoux at 720; and the editor (Xavier de Feller) of the small Geographical Dictionary of Vosgien, reprinted at Paris in 1778, at 370 millions. This last estimate is perhaps too low, although the writer professes to have taken considerable pains to ascertain the point with as much accuracy as the nature of the subject will admit. It may, perhaps, not be deemed unworthy the attention of the curious speculatist to observe, that assuming the more probable statement of the learned Jesuits of Trevoux, and that the world has existed about 6006 years in its present state of population, then the whole number of persons who have ever existed upon earth since the days of Adam amounts only to about one hundred and thirty thousand millions; because $720,000,000 \times 182$ (the number of generations in 6006 years) = 131,040,000,000. See on this subject the authors above mentioned, as likewise Beaufobre's *Etude de la Politique*.

With regard to the population of England, the reader may consult, together with our article *POLITICAL-Arithmetic*, An Inquiry into the present State of Population, &c. by W. Wales, F. R. S. and Mr Howlett's Examination of Dr Price's Essay, on the same subject.

POPULUS, the *POPLAR*: A genus of the octandria order, belonging to the diœcia class of plants; and in the natural method ranking under the 50th order, *Amentaceæ*. The calyx of the amentum is a lacerated, oblong, and squamous leaf; the corolla is turbinate, oblique, and entire. The female has the calyx of the amentum and corolla the same as in the male; the stigma is quadrifid; the capsule bilocular, with many pappous seeds.

The poplar, one of the most beautiful of the aquatic trees, has frequently been introduced into the poetical descriptions of the ancients; as by Virgil, *Ecl.* vii. 66. ix. 41. *Georg.* ii. 66. iv. 511. *Æn.* viii. 31. 276. by Ovid, *Amom. Parid.* 27. by Horace, *Carm.* ii. 3. and by Catulus, *Nupt. Pil. et Thet.* 290, &c. &c.

Species. 1. The alba, or abele-tree, grows naturally in the temperate parts of Europe. Its leaves are

large, and divided into three, four, or five lobes, indented on their edges, of a very dark colour on their upper side, but very white and downy on the under side; standing upon footstalks an inch long. The young branches have a purple bark, and are covered with a white down; but the bark of the stem and older branches is grey. In the beginning of April, the male flowers or catkins appear, which are cylindrical, and about three inches long. About a week after come out the female flowers or catkins, which have no stamina like those of the male. Soon after these come out, the male catkins fall off; and in five or six weeks after the female flowers will have ripe seeds inclosed in a hairy covering. The catkins will then drop, and the seeds be waisted by the winds to a great distance. 2. The major, or white poplar, has its leaves rounder than the first, and not much above half their size: they are indented on their edges, and are downy on their under side, but not so white as those of the former, nor are their upper surfaces of such a deep green colour. 3. The nigra, or black poplar, has oval heart-shaped leaves, slightly crenated on their edges; they are smooth on both sides, and of a light green colour. 4. The tremula, or aspen-tree, has roundish, angularly indented leaves: they are smooth on both sides, and stand on long footstalks, and so are shaken by the least wind; from whence it has the title of the *trembling poplar*, or *aspen-tree*. 5. The balsamifera, or Carolina poplar, is a native of Carolina, where it becomes a large tree. The shoots of this sort grow very strong in Britain, and are generally angular; with a light green bark like the willow. The leaves on young trees, and also those on the lower shoots, are very large, almost heart-shaped, and crenated; but those upon the older trees are smaller: as the trees advance, their bark becomes lighter, approaching to a greyish colour. 6. The tacamahaca, grows naturally in Canada and other parts of North America. This is a tree of a middling growth, sending out on every side many short thick shoots, which are covered with a light brown bark, garnished with leaves differing from one another in shape and size; most of them are almost heart-shaped; but some are oval, and others nearly spear-shaped; they are whitish on their under side, but green on their upper.

Culture. These trees may be propagated either by layers or cuttings, as also from suckers which the white poplars send up from their roots in great plenty. The best time for transplanting these suckers is in October, when their leaves begin to decay. These may be placed in a nursery for two or three years, to get strength before they are planted out where they are designed to remain; but if they are propagated from cuttings, it is better to defer the doing of that until February, at which time truncheons of two or three feet long should be thrust about a foot and a half into the ground.—These will readily take root; and if the soil in which they are planted be moist, they will arrive at a considerable bulk in a few years. The black poplar is less apt to take root from large truncheons; therefore it is a better method to plant cuttings of it about a foot and a half in length, thrusting them a foot deep in the ground. This sort will grow almost on any soil, but will thrive best in moist places. The Carolina poplar may also be propagated by cuttings or layers; but the last is the method generally practised, and the plants raised

Populus.

raised by it are less moist than others. The shoots of this tree, while young, are frequently killed down to a considerable length by the frost in winter; but as the trees grow older, their shoots are not so vigorous, and become more ligneous, so are not liable to the same disaster. But the trees should be planted in a sheltered situation: for as their leaves are very large, the wind has great power over them; and the branches being tender, they are frequently broken or split by the winds in summer, when they are much exposed. The tacamahaca sends up a great number of suckers from its roots, by which it multiplies in plenty; and every cutting which is planted will take root.

Uses. The wood of these trees, especially of the abele, is good for laying floors, where it will last for many years; and on account of its extreme whiteness is by many preferred to oak; yet, on account of its soft texture, being very subject to take the impression of nails, &c. it is less proper on this account than the harder woods. The abele likewise deserves particular notice, on account of the virtue of its bark in curing intermitting fevers. The Reverend Mr Stone, in Phil. Trans. vol. LIII. p. 195. tells us, that he gathers the bark in summer when it is full of sap, and having dried it by a gentle heat, gives a dram powdered every four hours betwixt the fits. In a few obstinate cases, he mixed one-fifth part of Peruvian bark with it. It is remarkable how nature has adapted remedies to diseases. Intermitting fevers are most prevalent in wet countries; and this tree grows naturally in such situations. The bark of it is an object well worthy the attention of physicians; and if its success upon a more enlarged scale of practice prove equal to Mr Stone's experiments, the world will be much indebted to him for communicating them. This bark will also tan leather.

The inner bark of the black poplar is used by the inhabitants of Kamshatka as a material for bread; and paper has sometimes been made of the cottony down of the seeds. The roots have been observed to dissolve into a kind of gelatinous substance, and to be coated over with a tubular crustaceous spar, called by naturalists *oste-*

* See *Osteo-ocolla**, formerly imagined to have some virtue in producing the callus of a fractured bone. The buds of the sixth species are covered with a glutinous resin, which smells very strong, and is the gum tacamahaca of the shops. The best, called, from its being collected in a kind of gourd-shells, *tacamahaca in shells*, is somewhat unctuous and softish, of a pale yellowish or greenish colour, an aromatic taste, and a fragrant delightful smell, approaching to that of lavender or ambergrise. This sort is very rare; that commonly found in the shops is in semitransparent globes or grains, of a whitish, yellowish, brownish, or greenish colour, of a less grateful smell than the foregoing. This resin is said to be employed externally by the Indians for discussing and maturing tumours, and abating pains in the limbs. It is an ingredient in some anodyne, hysseric, cephalic, and stomachic plasters; but the fragrance of the finer sort sufficiently points out its utility in other respects.

M. Fongeroux de Bondaroy, from a set of experiments

VOL. XV. Part I.

on the subject, gives an account of the uses of the several kinds of poplar, the substance of which is as follows: He finds that the wood of the black poplar is good and useful for many purposes; that the Lombardy poplar, *populus fastigata*, is of very little value; that the Virginia poplar, *populus Virginiana*, affords a wood of excellent quality, that may be applied to many uses. The Carolina poplar, *populus Carolinensis*—*heterophylla*, (Linn.) is a very quick grower; beautiful when sound, but liable to be hurt by cold. Its wood appeared to M. de Bondaroy to be of little value; but M. Malesherbes, who cut down a large tree of this sort, was assured by his carpenter that the wood was very good.—That the tacamahaca, *populus tacamahaca balsamifera*, is a dwarfish plant (A), of little value.—That the liard, *populus Canadensis*, is a large tree, the wood light, not easy to be split, and fit for several uses.—That the white poplar, *populus alba*, is a large growing tree, affording a wood of excellent quality, and is among the most valuable of this species.—That the trembling poplar, *populus tremula*, (Linn.) is neither so large a tree nor affords such wood as the former. There are in few words the principal result of the experiments of this gentleman on this class of plants. A few other sorts are mentioned, but nothing decisive with regard to them is determined.

From some experiments made by M. Dambourney, it appears that the poplar may be usefully employed in dyeing. The Italian poplar gives a dye of as fine a lustre, and equally durable, as that of the finest yellow wood, and its colour is more easily extracted. It is likewise very apt to unite with other colours in composition. Beside the *populus fastigata*, M. Dambourney tried also the black poplar, the Virginian *ditto*, the balsam *ditto* or *liard*, the white *ditto*, and the trembling poplar; and found that all these dyed wool of a nut-colour, fawn-colour (*vigogne*), Nankin, musk, and other grave shades, according to the quantity of wood employed, and the length of time it was boiled.

POQUELIN or POCQUELIN (John Baptist.) See MOLIERE.

PORANA, in botany; a genus of the monogynia order, belonging to the pentandria class of plants. The corolla is campanulated; the calyx is quinquefid, and larger than the fruit; the style semibifid, long, and permanent; the stigmata globular; the perianthium bivalved.

PORCELAIN, a fine kind of earthen ware, chiefly manufactured in China, and thence called *China-ware*. All earthen wares which are white and semitransparent are generally called *porcelains*: but amongst these, so great differences may be observed, that, notwithstanding the similarity of their external appearance, they cannot be considered as matters of the same kind. These differences are so evident, that even persons who are not connoisseurs in this way prefer much the porcelain of some countries to that of others.

The word *porcelain* is of European derivation; none of the syllables which compose it can even be pronounced or written by the Chinese, whose language comprehends

Populus
||
Porcelain.

What is
called por-
celain.

Porcelain. prehends no such sounds. It is probable that we are indebted to the Portuguese for it: the word *porcellana*, however, in their language, signifies properly a cup or dish; and they themselves distinguish all works of porcelain by the general name of *loca*. Porcelain is called in China *tsé-ki*.

3
Art of making it in greater perfection in the East than in Europe. The art of making porcelain is one of those in which Europe has been excelled by oriental nations. The first porcelain that was seen in Europe was brought from Japan and China. The whiteness, transparency, fineness, neatness, elegance, and even the magnificence of this pottery, which soon became the ornament of sumptuous tables, did not fail to excite the admiration and industry of Europeans; and their attempts have succeeded so well, that in different parts of Europe earthen wares have been made so like the oriental, that they have acquired the name of *porcelain*. The first European porcelains were made in Saxony and in France; and afterwards in England, Germany, and Italy: but as all these were different from the Japanese, so each of them had its peculiar character.

4
Best Chinese porcelain at King-te-tching. The finest and best porcelain of China is made in a village called *King-te-tching*, in the province of Kiang-si. This celebrated village is a league and a half in length, and we are assured that it contains a million of inhabitants. The workmen of King-te-tching, invited by the attracting allurements of the European trade, have established manufactories also in the provinces of Fokien and Canton; but this porcelain is not esteemed. The emperor Kang-hi was desirous of having some made under his own inspection at Pe-king. For this purpose he collected workmen, together with tools, and all materials necessary; furnaces were also erected; but the attempt miscarried. The village of *King-te-tching* still continues the most celebrated place in the empire for beautiful porcelain, which is transported to all parts of the world, and even to Japan.

5
Origin of the art. We are unable to discover who first found out the art of making porcelain, nor is it known whether the Chinese were indebted to chance for it, or to the repeated efforts of inventive genius; we cannot even determine its antiquity with precision; we know only from the annals of Feou-leang, a city in the district to which King-te-tching belongs, that, since the year 442 of our era, the workmen of this village have always furnished the emperors with porcelain; and that one or two mandarins were sent from court to inspect their labours. It is, however, supposed that the invention of porcelain is much older than that epocha.

6
F. d'Entrecolles first gave an account of Chinese porcelain. We are indebted to Father d'Entrecolles, a Romish missionary, for a very accurate account of the manner in which porcelain is made in China; and as he lived in King-te-tching, his information must have been the very best possible. We shall therefore give his account of the Chinese manner of making it, as abridged by Grofier in his *General Description of China*. The principal ingredients of the fine porcelain are *pe-tun-tse* and *kao-lin*, two kinds of earth from the mixture of which the paste is produced. The *kao-lin* is intermixed with small shining particles; the other is purely white, and very fine to the touch. These first materials are carried to the manufactories in the shape of bricks. The *pe-tun-tse*, which is so fine, is nothing else but fragments of rock taken from certain quarries, and reduced to powder. Every kind of stone is not fit for this purpose. The colour

7
Nature of the materials, and mode of preparing the paste.

of that which is good, say the Chinese, ought to incline a little towards green. A large iron club is used for breaking these pieces of rock: they are afterwards put into mortars; and, by means of levers headed with stone bound round with iron, they are reduced to a very fine powder. These levers are put in action either by the labour of men, or by water, in the same manner as the hammers of our paper-mills. The dust afterwards collected is thrown into a large vessel full of water, which is strongly stirred with an iron shovel. When it has been left to settle for some time, a kind of cream rises on the top, about four inches in thickness, which is skimmed off, and poured into another vessel filled with water: the water in the first vessel is stirred several times; and the cream which arises is still collected, until nothing remains but the coarse dregs, which, by their own weight, precipitate to the bottom: these dregs are carefully collected, and pounded anew.

With regard to what is taken from the first vessel, it is suffered to remain in the second until it is formed into a kind of crust at the bottom. When the water above it seems quite clear, it is poured off by gently inclining the vessel, that the sediment may not be disturbed; and the paste is thrown into large moulds proper for drying it. Before it is entirely hard, it is divided into small square cakes, which are sold by the hundred. The colour of this paste, and its form, have occasioned it to receive the name of *pe tun-tse*.

The kao-lin, which is used in the composition of porcelain, requires less labour than the pe-tun-tse. Nature has a greater share in the preparation of it. There are large mines of it in the bosoms of certain mountains, the exterior strata of which consist of a kind of red earth. These mines are very deep, and the kao-lin is found in small lumps, that are formed into bricks after having gone through the same process as the pe-tun-tse. Father d'Entrecolles thinks, that the earth called *terre de Malte*, or St Paul's earth, has much affinity to the kao-lin, although those small shining particles are not observed in it which are interspersed in the latter.

It is from the kao-lin that fine porcelain derives all its strength; if we may be allowed the expression, it stands it instead of nerves. It is very extraordinary, that a soft earth should give strength and consistency to the pe-tun-tse, which is procured from the hardest rocks. A rich Chinese merchant told F. d'Entrecolles, that the English and Dutch had purchased some of the pe-tun-tse, which they transported to Europe with a design of making porcelain; but having carried with them none of the kao-lin, their attempt proved abortive, as they have since acknowledged. "They wanted (said this Chinese, laughing) to form a body, the flesh of which should support itself without bones."

8
A new substance discovered and used by the Chinese. The Chinese have discovered, within these few years, a new substance proper to be employed in the composition of porcelain. It is a stone, or rather species of chalk, called *hoa-che*, from which the physicians prepare a kind of draught that is said to be detergent, aperient, and cooling. The manufacturers of porcelain have thought proper to employ this stone instead of kao-lin. It is called *hoa*, because it is glutinous, and has a great resemblance to soap. Porcelain made with *hoa-che* is very rare, and much dearer than any other. It has an exceeding fine grain, and, with regard to the painting, if it be compared with that of the common porcelain, it

Porcelain. it appears to surpass it as much as vellum does paper. This porcelain is, besides, so light, that it surprises those who are accustomed to handle other kinds; it is also much more brittle; and it is very difficult to hit upon the proper degree of tempering it.

Hoa-che is seldom used in forming the body of the work; the artist is contented sometimes with making it into a very fine size, in which the vessel is plunged when dry, in order that it may receive a coat before it is painted and varnished: by these means it acquires a superior degree of beauty.

When hoa-che is taken from the mine, it is washed in rain or river water, to separate it from a kind of yellow earth which adheres to it. It is then pounded, put into a tub filled with water to dissolve it, and afterwards formed into cakes like kao-lin. We are assured that hoa-che, when prepared in this manner, without the mixture of any other earth, is alone sufficient to make porcelain. It serves instead of kao-lin; but it is much dearer. Kao-lin costs only ten-pence Sterling; the price of hoa-che is half-a-crown: this difference, therefore, greatly enhances the value of porcelain made with the latter.

9
The splendor and whiteness of their porcelain derived from oil or varnish.

To pe-tun-tse and kao-lin, the two principal elements, must be added the oil or varnish from which it derives its splendor and whiteness. This oil is of a whitish colour, and is extracted from the same kind of stone which produces the pe-tun-tse, but the whitest is always chosen, and that which has the greenest spots. The oil is obtained from it by the same process used in making the pe-tun-tse: the stone is first washed and pulverized; it is then thrown into water, and after it has been purified it throws up a kind of cream. To 100 pounds of this cream is added one pound of che-kao, a mineral something like alum, which is put into the fire till it becomes red-hot and then pounded. This mineral is a kind of runnet, and gives a consistence to the oil, which is however carefully preserved in its state of fluidity. The oil thus prepared is never employed alone, another oil must be mixed with it, which is extracted from lime and fern ashes, to 100 pounds of which is also added a pound of che-kao. When these two oils are mixed, they must be equally thick; and in order to ascertain this, the workmen dip into each of them some cakes of the pe-tun-tse, and by inspecting their surfaces, closely after they are drawn out, thence judge of the thickness of the liquors. With regard to the quantity necessary to be employed, it is usual to mix 10 measures of stone-oil with one measure of the oil made from lime and fern ashes.

10
Their mode of mixing the substances,

The first labour consists in again purifying the pe-tun-tse and the kao-lin. The workmen then proceed to mix these two substances together. For fine porcelain they put an equal quantity of the kao-lin and the pe-tun-tse; for the middling sort they use four parts of the kao-lin and six of the pe-tun-tse. The least quantity put of the former is one part to three of the pe-tun-tse. When this mixture is finished, the mass is thrown into a large pit, well paved and cemented in every part; it is then trod upon, and kneaded until it becomes hard. This labour is so much the more fatiguing, as it must be continued without intermission: were it interrupted, all the other labourers would remain unemployed. From this mass, thus prepared, the workmen detach different pieces, which they spread out

upon large slates, where they knead and roll them in every direction, carefully observing to leave no vacuum in them, and to keep them free from the mixture of any extraneous body. A hair or a grain of sand would spoil the whole work. When this paste has not been properly prepared, the porcelain cracks, and melts or becomes warped.

All plain works are fashioned with the wheel. When a cup has undergone this operation, the outside of its bottom is quite round. The workman first gives it the requisite height and diameter, and it comes from his hands almost the moment he has received it. He is under the necessity of using expedition, as he is paid not quite a farthing per board, and each board contains 26 pieces. This cup passes then to a second workman, who forms its base. A little after it is delivered to a third, who applies it to his mould, and gives it a proper form; when he takes it off the mould, he must turn it very softly, and be careful not to press it more on one side than on another; without this precaution it would become warped or disfigured. A fourth workman polishes it with a chisel, especially around the edges, and diminishes its thickness, in order to give it a certain degree of transparency. At length, after having passed through all the hands necessary for giving it all its ornaments, it is received, when dry, by the last workman, who fashions its bottom with a chisel. It is astonishing to see with what dexterity and expedition the workmen convey these vases from one to another. We are assured, that a piece of porcelain, before it is finished, must pass through the hands of 70 persons.

Large works are executed in parts which are fashioned separately. When all the pieces are finished, and almost dry, they are put together and cemented with paste made of the same substance, and softened with water. Some time after, the seams are polished with a knife, both without and within; and when the vessel is covered with varnish, it entirely conceals them, so that the least trace of them is not to be seen. It is in this manner that spouts, handles, rings, and other parts of the same nature, are added. This is the case, particularly in those pieces which are fashioned upon moulds or modelled with the hands, such as embossed works, grotesque images, idols, figures of trees or animals, and busts, which the Europeans order. All these are formed of four or five pieces joined together, which are afterwards brought to perfection with instruments proper for carving, polishing, and finishing, the different traces which the mould has left imperfect. With regard to those flowers and ornaments which are not in relief, they are either engraven or imprinted with a stamp. Ornaments in relief, prepared separately, are also added to pieces of porcelain, almost in the same manner as lace is put upon a coat.

After a piece of porcelain has been properly fashioned, it then passes into the hands of the painters. These hoa-pei, or painters in porcelain, are equally indigent as the other workmen; they follow no certain plan in their art, nor are they acquainted with any of the rules of drawing; all their knowledge is the effect of practice, assisted by a whimsical imagination. Some of them, however, show no inconsiderable share of taste in painting flowers, animals, and landscapes, on porcelain, as well as upon the paper of fans, and the silk used for filling up the squares of lanterns. The labour of painting,

Porcelain.

11
And of fashioning the works.

12
Large works executed in parts and cemented.

13
Their manner of painting porcelain;

Porcelain.

in the manufactories of which we have spoken, is divided among a great number of hands. The business of one is entirely confined to tracing out the first coloured circle, which ornaments the brims of the vessel; another designs the flowers, and a third paints them; one delineates waters and mountains, and another birds and other animals: human figures are generally the worst executed.

14
And of making it appear covered with veins.

The *tsou-you*, which is a kind of oil procured from white flint, has the peculiar property of making those pieces of porcelain upon which it is laid appear to be covered with an infinitude of veins in every direction; at a distance one would take them for cracked vases, the fragments of which have not been displaced. The colour communicated by this oil is a white, somewhat inclining to that of ashes. If it be laid upon porcelain, entirely of an azure blue, it will appear in the same manner to be variegated with beautiful veins. This kind of porcelain is called *tsou-ki*.

15
A singular secret which they have now lost.

The Chinese make vases also ornamented with a kind of fret-work, perforated in such a manner as to resemble very fine lace. In the middle is placed a cup proper for holding any liquid; and this cup makes only one body with the former, which appears like lace wrapped round it. The Chinese workmen had formerly the secret of making a still more singular kind of porcelain: they painted upon the sides of the vessel fishes, insects, and other animals, which could not be perceived until it was filled with water. This secret is in a great measure lost: the following part of the process is, however, preserved. The porcelain, which the workman intends to paint in this manner, must be extremely thin and delicate. When it is dry, the colour is laid on pretty thick, not on the outside, as is generally done, but on the inside. The figures painted upon it, for the most part, are fishes, as being more analogous to the water with which the vessel is filled. When the colour is thoroughly dry, it is coated over with a kind of size, made from porcelain-earth; so that the azure is entirely inclosed between two laminæ of earth. When the size becomes dry, the workman pours some oil into the vessel, and afterwards puts it upon a mould and applies it to the lath. As this piece of porcelain has received its consistence and body within, it is made as thin on the outside as possible, without penetrating to the colour; its exterior surface is then dipped in oil, and when dry it is baked in a common furnace. The art of making these vases requires the most delicate care, and a dexterity which the Chinese perhaps do not at present possess. They have, however, from time to time made several attempts to revive the secret of this magic painting, but their success has been very imperfect. This kind of porcelain is known by the name of *kia-tsing*, "pressed azure."

16
Their mode of baking porcelain.

After the porcelain has received its proper form, its colours, and all the intended ornaments, it is transported from the manufactory to the furnace, which is situated sometimes at the other end of King-te-tching. In a kind of portico, which is erected before it, may be seen heaps of boxes and cases made of earth, for the purpose of inclosing the porcelain. Each piece, however inconsiderable it may be, has its case; and the Chinese workman, by this procedure, imitates nature, which, in order to bring the fruits of the earth to proper maturity, clothes them in a covering, to defend them from the

excessive heat of the sun during the day, and from the severity of the cold during the night.

Porcelain.

In the bottom of these boxes is put a layer of fine sand, which is covered over with powder of the *kao-lin*, to prevent the sand from adhering too closely to the bottom of the vessel. The piece of porcelain is then placed upon this bed of sand, and pressed gently down, in order that the sand may take the form of the bottom of the vessel, which does not touch the sides of its case: the case has no cover. A second, prepared in the same manner, and containing its vessel, is fitted into the first, so that it entirely shuts it, without touching the porcelain which is below; and thus the furnace is filled with piles of cases, which defend the pieces they contain from the too direct action of the fire.

With regard to small pieces of porcelain, such as tea-cups, they are inclosed in common cases about four inches in height. Each piece is placed upon a saucer of earth about twice as thick as a crown-piece, and equal in breadth to its bottom. These small cases are also sprinkled over with the dust of the *kao-lin*. When the cases are large, the porcelain is not placed in the middle, because it would be too far removed from the sides, and consequently from the action of the fire.

These piles of cases are put into the furnace, and placed upon a bed of coarse sand, half a foot in thickness; those which occupy the middle space are at least seven feet high. The two boxes which are at the bottom of each pile remain empty, because the fire acts too feebly upon them, and because they are partly covered by the sand. For the same reason, the case placed at the top of each pile is also suffered to be empty. The piles which contain the finest porcelain are placed in the middle part of the furnace; the coarsest are put at its farther extremity; and those pieces which have the most body and the strongest colouring are near its mouth.

These different piles are placed very closely in the furnace; they support each other mutually by pieces of earth, which bind them at the top, bottom, and middle; but in such a manner that a free passage is left for the flame to insinuate itself everywhere around them.

Before each of these furnaces for baking porcelain there is a long porch, which conveys air, and supplies in certain respects the place of a bellows. It serves for the same purposes as the arch of a glasshouse. "These furnaces (says Father d'Entrecolles), which were formerly only six feet in height and the same in length, are constructed now upon a much larger plan: at present they are two fathoms in height, and almost four in breadth; and the sides and roof are so thick, that one may lay the hand upon them without being incommoded by the heat. The dome or roof is shaped like a funnel, and has a large aperture at the top, through which clouds of flame and smoke incessantly issue. Besides this principal aperture, there are five others smaller, which are covered with broken pots, but in such a manner that the workman can increase or diminish the heat according as it may be found most convenient: through these also he is enabled to discover when the porcelain is sufficiently baked. Having uncovered that hole which is nearest the principal aperture, he takes a pair of pincers, and opens one of the cases: if he observes a bright fire in the furnace, if all the cases be

17
Nature of their furnaces.

red-

Porcelain. red-hot, and if the colours of the porcelain appear with full lustre, he judges that it is in a proper state; he then discontinues the fire, and entirely closes up the mouth of the furnace for some time. In the bottom of the furnace there is a deep hearth about two feet in breadth, over which a plank is laid, in order that the workman may enter to arrange the porcelain. When the fire is kindled on this hearth, the mouth of the furnace is immediately closed up, and an aperture is left only sufficient for the admission of faggots about a foot in length, but very narrow. The furnace is first heated for a day and night; after which two men keep continually throwing wood into it, and relieve each other by turns: 180 loads are generally consumed for one baking. As the porcelain is burning hot, the workman employs for the purpose of taking it out long scarfs or pieces of cloth, which are suspended from his neck."

18
Their different classes of porcelain.

The Chinese divide their porcelain into several classes, according to its different degrees of fineness and beauty. The whole of the first is reserved for the emperor. None of these works ever come into the hands of the public, unless they have blemishes or imperfections which render them unworthy of being presented to the sovereign. It is much to be doubted whether any of the largest and finest porcelain of China has ever been brought to Europe; the missionaries at least assure us that none of that kind is sold at Canton. The Chinese set some value upon the Dresden porcelain, and still more upon that which comes from the manufactories of France.

19
Porcelain first examined scientifically by Reaumur.

The illustrious Reaumur first attended to the manufacture of porcelain as a science, and communicated his researches in two memoirs before the Academy of Sciences in 1727 and 1729. He did not satisfy himself with considering the external appearance, the painting and gilding, which are only ornaments not essential to the porcelain, but he endeavoured to examine it internally; and having broken pieces of the Japanese, Saxon, and French porcelains, he examined the difference of their grains (which name is given to their internal structure). The grain of the Japanese porcelain appeared to him to be fine, close, compact, moderately smooth, and somewhat shining. The grain of the Saxon porcelain was found to be still more compact, not granulous, smooth, shining like enamel. Lastly, the porcelain of St Cloud had a grain much less close and fine than that of Japan; not, or but little, shining; and resembling the grain of sugar.

20
Different kinds of it.

From these first observations Mr Reaumur perceived that porcelains differed considerably. That he might examine them further, he exposed them to a violent heat. More essential differences than those of the grain appeared upon this trial; for the Japanese porcelain was unalterable by the fire, and all the European were melted.

21
Its true composition discovered by Reaumur.

This essential difference betwixt the Japanese and European porcelains suggested to Mr Reaumur a very ingenious thought, and in many respects true, concerning the nature of porcelain in general. As all porcelains somewhat resemble glass in consistence and transparency, though they are less compact and much less transparent, Mr Reaumur considered them as semivitrifications. But every substance may appear, and may actually be, in a semivitrified state in two ways: for, first,

it may be entirely composed of vitrifiable or fusible matters; and in this case, by exposing it to the action of fire, it will be actually melted or vitrified, if the heat be sufficiently strong and long continued. But as this change is not made instantly, especially when the heat is not very violent; and as it passes through different stages or degrees, which may be more easily observed as the heat is better managed: hence, by stopping in proper time the application of heat to porcelain made in this manner, we may obtain it in an intermediate state betwixt those of crude earths and of completely vitrified substances, and also possessed of the semitransparency and of the other sensible qualities of porcelain. We know also, that if such porcelain be exposed to a stronger degree of heat, it will then be completely fused and entirely vitrified. But the European porcelains tried by Mr Reaumur had this fusibility; from which he concluded, that their composition is founded upon the above-mentioned principle.

In the second place, a paste of porcelain may be composed of fusible and vitrifiable matter, mixed with a certain proportion of another matter which is absolutely unfusible in the fires of our furnaces. We may easily perceive, that if such a mixture be exposed to a heat sufficient to melt entirely the vitrifiable ingredient, that this matter will actually melt: but as it is intermixed with another matter which does not melt, and which consequently preserves its consistency and opacity, the whole must form a compound partly opaque and partly transparent, or rather a semitransparent mass; that is, a semivitrified substance or porcelain, but of a kind very different from the former; for as the fusible part of this latter has produced all its effect, and as it has been as much fused as it can be during the baking of the porcelain, the compound may be exposed a second time to a more violent fire, without approaching nearer to a complete vitrification, or without departing from its state of porcelain. But as oriental porcelain has precisely these appearances and properties, Mr Reaumur concludes with reason, that it is composed upon this principle; and he afterwards confirmed his opinion by undeniable facts.

Mr Reaumur examined the pe-tun-tse and kao-lin of the Chinese, and having exposed them separately to a violent fire, he discovered that the pe-tun-tse had fused without addition, and that the kao-lin had given no sign of fusibility. He afterwards mixed these matters, and formed cakes of them, which by baking were converted into porcelain similar to that of China. Mr Reaumur easily found, that the pe-tun-tse of the Chinese was a hard stone of the kind called *vitrifiable*, but much more fusible than any of those which were known in Europe; and that the kao-lin was a talky matter, reduced to a very fine powder. From that time he hoped to make a porcelain of the same kind as the Chinese with materials found in France. Whether he could not find any materials equal to those of China, particularly that material analogous to the pe-tun-tse of the Chinese, or because other occupations prevented the continuance of his researches, we do not know; but we find, from his second memoir upon porcelain, that he afterwards attempted to make an artificial pe-tun-tse, by mixing our vitrifiable stones with salts capable of rendering them fusible, or even by substituting for it glass ready formed, and by adding to these such substances

Porcelain stances as he thought might be substituted for kao-lin. But he probably found he could not execute these intentions; for he did not resume this subject from the year 1729 to 1739, when he gave a process for converting common glass to a singular kind of porcelain, to which he had given his name, and of which an account is given under CHEMISTRY, n^o 591—594. See also the article *Glass-Porcelain*.

22 Who converted
23 He is mistaken
in some particulars,

Although Mr Reaumur has surmounted many difficulties, and has given just notions concerning this subject, yet he has been mistaken, or rather misled, in two important points. His first error concerns the Saxon porcelain, which he confounds with the other fusible porcelains made in Europe. Formerly, indeed, a porcelain might be made in Saxony, composed entirely of fusible or vitrifiable materials, the vitrification of which was sloop in proper time, and which Mr Reaumur had examined. But now we are certainly informed, that all of that country is capable of resisting the most violent fires without fusion, as well at least as those of China and Japan. Mr Reaumur might have been misled by the appearance of the internal texture of this porcelain. For when a piece of it is broken, its internal surface does not appear granulous, but compact, uniform, smooth, shining, and much resembling white enamel. But this appearance, so far from showing that Saxon porcelain is a fused or vitrified substance, proves that it is not entirely composed of fusible matters. All who have considered attentively this subject know, that the internal surface of the most fusible porcelains is also the least dense and least compact; the reason of which is, that no vitreous matter can be smooth and dense internally, unless it has been completely fused. But if the density and shining appearance of the internal surface of the Saxon porcelain were only the effects of the fusion of a vitreous matter, how could we conceive that vessels formed of that matter should have sustained the necessary fusion for giving this density and shining appearance, without having entirely lost their shape? The impossibility of this is evident to any persons who have been conversant in these matters and in the fusion of glass.

24 Difference between
Saxon and
oriental
porcelain

This quality of the Saxon porcelain must therefore proceed from another cause. It does indeed contain, as every porcelain does, particularly those of China and Japan, a fusible substance, which has been even completely fused during the baking. Its density also, and its internal lustre, proceed chiefly from this fused matter: but we are also certain, that it contains a large quantity of a substance absolutely unfusible, from which it receives its admirable whiteness, its firmness and solidity, during the baking; in a word, which supplies the place of the oriental kao-lin, and which has the property of contracting its dimensions considerably while it incorporates with the fusible substance. If it be subjected to the most decisive trial, namely, the action of a violent fire, capable of melting every porcelain composed of fusible matters alone, "I affirm (says Mr Macquer), after many experiments, that it cannot be fused, unless by a fire capable also of melting the best Japanese porcelain." The Saxon porcelain is therefore not to be confounded with those which are vitreous and fusible; but is in its kind as excellent as that of Japan, and perhaps superior, as we shall see when we enu-

Chem. Dict.

rate the qualities which constitute the excellence of porcelain. The subject of Mr Reaumur's second error, or at least that which he has not sufficiently explained, is the kao-lin of China. According to him, this matter is a fine talky powder, from the mixture of which with pe-tun-tse the oriental porcelain is formed. Possibly a very finely ground talky substance mixed with pe-tun-tse might form a porcelain similar to the oriental; but persons acquainted with the manufacture of any porcelain must perceive the impossibility of forming vessels, unless the paste of which they are made be so ductile and tenacious that it may be worked upon a potter's lathe, or at least that it may be moulded. But talks, or any kinds of stones, however finely ground, cannot acquire the requisite tenacity, which clays only, of all known earthy substances, possess. The Chinese porcelain vessels evidently appear to be turned upon the lathe, since they retain the marks of it: hence they must have been formed of a very tenacious paste, and consequently the kao-lin is not a purely talky matter, but is mixed with clay; or else the pe-tun-tse and kao-lin are not, as Mr Reaumur supposes, the only ingredients of which Chinese porcelain is formed, but a sufficient quantity of some binding matter, unknown to Father d'Entrecolles and Mr Reaumur, must be also added.

25 Although, since Mr Reaumur, no scientific person has written concerning porcelain, many have attempted to make it. Manufactories have been established in most all the states of Europe. Besides that of Saxony, which has been long established, porcelain is also made at Vienna, at Frankendal, and lately in the neighbourhood of Berlin. All these German porcelains are similar to the Saxon; and are made of materials of the same kind, although they differ somewhat from each other. England and Italy also have their porcelains, the chief of which are those of Chelsea and of Naples. M. de la Condamine, in his last journey into Italy, visited a manufacture of porcelain established at Florence by the marquis de la Ginori, then governor of Leghorn. M. de la Condamine observed particularly the large size of some pieces of this porcelain. He says he saw statues and groups half as large as nature, modelled from some of the finest antiques. The furnaces in which the porcelain was baked were constructed with much art, and lined with bricks made of the porcelain materials. The paste of this porcelain is very beautiful; and from the grain of broken pieces, it appears to have all the qualities of the best Chinese porcelain. A whiter glazing would be desirable, which they might probably attain, if the Marquis Ginori was not determined to use those materials only which were found in that country.

But in no state of Europe have such attempts been made to discover porcelain, or so many manufactories of it been established, as in France. Before even Mr Reaumur had published on this subject, porcelain was made at St Cloud, and in the suburb of St Antoine at Paris, which was of the vitreous and fusible kind, but considerably beautiful. Since that time, considerable manufactories of it have been established at Chantilly, at Villeroi, and at Orleans; the porcelains of which have a distinguished merit. But the porcelain produced in the king's manufacture at Sevres holds at present the first rank from its shining white, its beautiful glazing, and coloured grounds, to which no porcelain

Porcelain. has ever equalled it. The magnificence of the gilding, the regularity and elegance of its forms, surpasses every thing of the kind.

26
M. Guettard's discoveries.

Mr Guettard has published an account of his discoveries on this subject, in the Memoirs of the Academy of Sciences for the year 1765. The kaolin which he employed was a white argillaceous earth, filled with mica, which he found in the neighbourhood of Alençon; and his pe-tun-tse is a hard, quartzose, grit stone, found abundantly in the same country, with which the streets of Alençon are paved. We also know that Mr Guettard had begun to make his experiments on porcelain with these materials in the year 1751, together with the then Duke of Orleans, to whom he was attached. The Count de Lauraguais, of the Academy of Sciences, engaged in the pursuit of porcelain for several years with uncommon ardour and constancy. He spared no trouble nor expence to attain his purpose, which was to make porcelain equal in all respects to that of China and Japan. He showed some pieces made by him in the year 1766 to the members of the Academy of Sciences. The persons appointed by them to examine it gave their opinion, "that of all the porcelains made in the country, that of the Count de Lauraguais most resembles the porcelain of China and Japan in solidity, grain, and unfusibility." It were to be wished that it possessed equally the other qualities essential to the excellence of porcelain, namely, the whiteness and lustre observable in the ancient Japanese porcelain.

27
In what the perfection of porcelain consists.

We shall now show what those qualities are which constitute the perfection of porcelain. We must first carefully distinguish the qualities which only contribute to the beauty and external appearance, from the intrinsic and essential properties in which the goodness and solidity of porcelain consist. All persons who have made experiments in this way have soon discovered the possibility of making compounds very white, beautifully semi-transparent, and covered with a shining glazing; but which cannot be worked for want of tenacity, are not sufficiently compact, are essentially fusible, are subject to break by sudden application of heat and cold; and, lastly, the glazing of which cracks, becomes rough, and consequently loses its lustre by use, because it is too soft.

On the other side, we shall also find it not difficult to compose very tenacious pastes which shall be capable of being easily worked and well baked; which in the baking shall acquire the desirable hardness and density; which are unfusible, and capable of sustaining very well the sudden change of heat and cold; and, in a word, which shall have all the qualities of the most excellent porcelain excepting whiteness and beauty. We shall soon see that the materials fit for the composition of such porcelains may be found abundantly in every country. The only difficulty, then, in this inquiry concerning porcelain, is to unite beauty and goodness in one composition; and indeed nature seems to be very sparing of materials fit for this purpose, and therefore perfect porcelain will always be a dear and valuable commodity.

28
Stone-ware a kind of porcelain.

Those potteries which we call *stone-ware* are not of modern invention, and have all the essential qualities of the best Japanese. For if we except whiteness, on which alone the semi-transparency depends, and compare all the properties of Japanese porcelain with those of our

stone-ware, no difference can be found betwixt them. Porcelain. The same grain appears internally in both; the same sound is produced by striking them when properly suspended; the same density, the same hardness by which they strike fire with steel, the same faculty of sustaining the heat of boiling liquors without breaking, and the same unfusibility in fire, are observable. Lastly, if the earths of which stone-ware is made were free from heterogeneous colouring matters, which prevent their whiteness and semi-transparency; if vessels were carefully formed; if all the proper attentions were given; and if these vessels were covered over with a fine glazing—they would be as perfect porcelain as that of Japan. The most perfect porcelain, therefore, is nothing else than a fine white stone-ware.

Earths of this kind are probably more rare in Europe than in Japan and China. And probably also the want of these earths was the cause that the first makers of porcelain in this country confined themselves to an external imitation, by employing nothing but vitrifiable matters with fusible salts and a small quantity of white earth, from which fusible and vitreous porcelains were composed, which might be called *false porcelains*. But Genuine things are much changed since these first attempts. Be- porcelain made in some countries of Europe. Besides the discoveries of the Count de Lauraguais and of Mr Guettard, genuine white porcelains have been made a long time ago in Germany, especially in Saxony and at Frankendal.

These porcelains are not inferior in any respect to the oriental; they are even much superior in beauty and whiteness to the modern oriental porcelain, which has much degenerated in these respects; they seem even to excel the oriental in the most valuable quality of porcelain, namely, the property of sustaining the sudden change of heat and cold. We cannot judge of the quality of porcelain by a slight trial: for so many circumstances concur to make a piece of porcelain capable or incapable of sustaining the sudden application of heat and of cold, that if at the same time boiling water be poured into two vessels, one of which is good porcelain and the other bad, the former may possibly break and the latter remain entire. The only true method of discovering good porcelain in this respect is, to examine several pieces of it which are daily used; for instance, a set of coffee-cups. But it has been observed, that in many such pieces of oriental porcelain, which have been long and daily used, cracks in the direction of their height may be always perceived, which are never seen in the good European porcelains.

Every one talks of porcelain, and yet few are con- Excellency of the ancient Japanese porcelain. noisseurs of it. None can be considered as such but those who have long made it an object of their inquiries. That the ancient Japanese porcelain is the most perfect is a general opinion. This porcelain is indeed very beautiful, and we must also acknowledge that its quality is excellent. It has been our model, and has long been the object of our admiration and emulation; but which we have been never able to equal, and which many persons believe never can be equalled. Some persons even decry the Saxon porcelain for a quality which really gives it a superiority to the Japanese, namely, the greater smoothness, lustre, and less granulous appearance of its internal surface than the oriental. The resemblance of this surface to that of glass has evidently suggested this notion; and it would be well founded if the density

Porcelain. density and lustre of this porcelain proceeded only from a fusible and vitreous quality; but as they do not, and as this porcelain is as fixed and as unfusible as the Japanese, its density, so far from being a fault, is a valuable quality: for we must allow, that of porcelains equal in other respects, those are best which are most firm and compact. Hence the interior substance of the Japanese porcelain is esteemed for its greater density, compactness, and lustre, than our vitreous sand or fritt porcelains; because these qualities indicate greater cohesion, and more intimate incorporation of its parts. For the same reason also the superior density of the Saxon porcelain ought to give it the preference to the Japanese. Besides, nothing would be easier than to give the Saxon porcelain the granulous texture of the Japanese, by mixing with the paste a certain quantity of sand. But the persons who perfected that manufacture were certainly sensible that such a conformity to the Japanese porcelain would lessen the merit of theirs: for we know, that in general porcelains are better in proportion as they contain a larger proportion of clay or earth, and less of sand, flints, or other matters of that kind.

What we have said concerning porcelain in general, and the principal kinds of it, seems sufficient to give just notions of it, if not to persons who without considering the subject are determined to prefer the most ancient, to those, at least, who have made experiments on this subject, or who, having a sufficient knowledge of chemistry, are capable of studying and examining it thoroughly. We shall finish this article by giving a short description of the method of manufacturing porcelain as practised in Europe.

81
Of making
fusible or
vitreous
porcelains.

The basis of the porcelains which we have called *fusible, vitreous, or false porcelains*, is called by artists a *fritt*; which is nothing else than a mixture of sand or of powdered flints, with salts capable of disposing them to fusion, and of giving them a great whiteness by means of a sufficient heat. This fritt is to be then mixed with as much, and no more, of a white tenacious earth of an argillaceous or marly nature, than is sufficient to make it capable of being worked upon the wheel. The whole mixture is to be well ground together in a mill, and made into a paste, which is to be formed, either upon the wheel or in moulds, into pieces of such forms as are required.

Each of these pieces, when dry, is to be put into a case made of earthen ware (A); which cases are to be ranged in piles one upon another, in a furnace or kiln, which is to be filled with these to the roof. The furnaces are chambers or cavities of various forms and sizes; and are so disposed, that their fire-place is placed on the outside opposite to one or more openings, which communicate within the furnace. The flame of the fuel is drawn within the furnace, the air of which rarefying, determines a current of air from without inwards, as in all furnaces. At first a very little fire is made, that the furnace may be heated gradually, and is to be increased

more and more till the porcelain is baked, that is, till it has acquired its proper hardness and transparency; which is known by taking out of the furnace from time to time, and examining, small pieces of porcelain, placed for that purpose in cases which have lateral openings. When these pieces show that the porcelain is sufficiently baked, the fritt is no longer to be supplied with fuel, the furnace is to be cooled, and the porcelain taken out, which in this state resembles white marble not having a shining surface, which is afterwards to be given by covering them with a vitreous composition called the *glazing*.

The porcelain when baked and not glazed is called *biscuit*, which is more or less beautiful according to the nature of the porcelain. The manufacture of Sévres excels all others in this respect, and it is therefore the only one which can produce very fine pieces of sculpture; that is, in which all the fineness of the workmanship is preserved, and which are preferable in smoothness and whiteness to the finest marble of Italy.

As no piece of sculpture of this kind can preserve all the delicacy of its workmanship when covered with a glazing, and as sculptors avoid polishing their marble figures, because the lustre of the polish is disadvantageous; therefore, in the manufactures of Sévres, all figures or little statues, and even some ornamental vases, are left in the state of biscuit. The other pieces of porcelain are to be glazed in the following manner.

A glass is first to be composed suited to the nature of the porcelain to which it is to be applied; for every glass is not fit for this purpose. We frequently find that a glass which makes a fine glazing for one porcelain shall make a very bad glazing for another porcelain; shall crack in many places, shall have no lustre, or shall contain bubbles. The glazing, then, must be appropriated to each porcelain, that is, to the hardness and density of the ware, and to the ingredients of its composition, &c.

These glazings are prepared by previously fusing together all the substances of which they consist, so as to form vitreous masses. These masses are to be ground very finely in a mill. This vitreous powder is to be mixed with a sufficient quantity of water, or other proper liquor, so that the mixture shall have the consistence of cream of milk. The pieces of porcelain are to be covered with a thin stratum of this matter; and when very dry, they are to be again put into the furnace in the same manner as before for the forming of the biscuit, and to be continued there till the glazing be well fused. The necessary degree of fire for fusing the glazing is much less than that for baking the paste.

The pieces of porcelain which are intended to remain white are now finished; but those which are to be painted and gilded must undergo further operations. The colours to be applied are the same as those used for enamel painting. They all consist of metallic calces bruised and incorporated with a very fusible glass. Cro-

cus

(A) The cases are called by English potters *seggars*. They are generally formed of coarser clays, but which must be also capable of sustaining the heat required without fusion. By means of these cases the contained porcelain is preserved from the smoke of the burning fuel. The whiteness of the porcelain depends much on their compactness of texture, by which the smoke is excluded, and on the purity of the clay of which they are made.

Porcelain,
Porch.

* See *Chemistry*, n^o
227.

34
Preparation of unfusible porcelain.

cus of iron furnishes a red colour; gold * precipitated by tin makes the purple and violet; copper calcined by acids and precipitated by an alkali gives a fine green; zaffre makes the blue; earths slightly ferruginous produce a yellow; and, lastly, brown and black colours are produced by calcined iron, together with a deep blue of zaffre. These colours being ground with gum-water, or with oil of spike, are to be employed for the painting of the porcelain with designs of flowers and other figures. For gilding, a powder or calx of gold is to be applied in the same manner as the coloured enamels. The painted and gilded porcelains are to be then exposed to a fire capable of fusing the glass, with which the metallic colours are mixed. Thus the colours are made to adhere, and at the same time acquire a gloss equal to that of the glazing. The gold alone has not then a shining appearance, which must be afterwards given to it by burnishing with a blood-stone.

The operations for the unfusible porcelains, and also for such as are of the nature of stone-ware, are somewhat more simple. The sands and stones which enter into their composition are to be ground in a mill: the earths or clays are to be washed: the materials are to be well mixed, and formed into a paste: the pieces are first rudely formed upon a potter's wheel; and when dry, or half dry, they are turned again upon the wheel, and their form is made more perfect: they are then placed in the furnace; not to bake them, but only to apply a sufficient heat to give them such a solidity that they may be handled without breaking, and may receive the glazing. As the pieces of porcelain after this slight heat are very dry, they imbibe water readily. This disposition assists the application of the glazing. The vitrifiable or vitrified matter of this glazing, which has been previously ground in a mill, is to be mixed with such a quantity of water, that the liquor shall have the consistence of milk. The pieces of porcelain are hastily dipt in this liquor, the water of which they imbibe, and thus on their surface is left an uniform covering of the glazing materials. This covering, which ought to be very thin, will soon become so dry, that it cannot stick to the fingers when the pieces are handled.

The pieces of this porcelain are then put into the furnace to be perfectly baked. The heat is to be raised to such a height, that all within the furnace shall be white, and the cases shall be undistinguishable from the flame. When, by taking out small pieces, the porcelain is known to be sufficiently baked, the fire is discontinued, and the furnace cooled. If the baking has been well performed, the pieces of porcelain will be found by this single operation to be rendered compact, sonorous, close-grained, moderately glossy, and covered externally with a fine glazing. The painting and gilding of this porcelain are to be executed in a manner similar to that already described.

PORCELAIN-Shell, a species of *CYPRÆA*.

PORCH, in architecture, a kind of vestibule supported by columns; much used at the entrance of the ancient temples, halls, churches, &c.

A porch, in the ancient architecture, was a vestibule, or a disposition of insulated columns usually crowned with a pediment, forming a covert place before the principal door of a temple or court of justice. Such is that before the door of St Paul's, Covent-Garden, the work of Inigo Jones. When a porch had four columns

VOL. XV. Part I.

in front, it was called a *tetrapyle*; when six, *hexapyle*; when eight, *octopyle*, &c.

PORCH, in Greek *σῑα*, a public portico in Athens adorned with the pictures of Polygnotus and other eminent painters. It was in this portico that Zeno the philosopher taught; and hence his followers were called *Stoics*. See *STOICS* and *ZENO*.

PORCUPINE, in zoology. See *HYSTRIX*.

PORCUPINE-Man, the name by which one Edward Lambert, who had a distempered skin, went in London. We have the following account of him in the Philosophical Transactions for 1755, by Mr Henry Baker, F. R. S. "He is now (says he) 40 years of age, and it is 24 years since he was first shown to the society. The skin of this man, except on his head and face, the palms of his hands, and the soles of his feet, is covered with excrescences that resemble an innumerable company of warts, of a brown colour and cylindrical figure; all rising to an equal height, which is about an inch, and growing as close as possible to each other at their basis; but so stiff and elastic as to make a rustling noise when the hand is drawn over them. These excrescences are annually shed, and renewed in some of the autumn or winter months. The new ones, which are of a paler colour, gradually rise up from beneath as the old ones fall off; and at this time it has been found necessary for him to lose a little blood, to prevent a slight sickness which he had been used to suffer before this precaution was taken. He has had the smallpox, and he has been twice salivated, in hopes to get rid of this disagreeable covering; but though just when the pustules of the smallpox had scaled off, and immediately after his salivations, his skin appeared white and smooth, yet the excrescences soon returned by a gradual increase, and his skin became as it was before. His health, during his whole life, has been remarkably good: but there is one particular of this case more extraordinary than all the rest; this man has had six children, and all of them had the same rugged covering as himself, which came on like his own about nine weeks after the birth. Of these children only one is now living, a pretty boy, who was shown with his father. It appears, therefore, as Mr Baker remarks, that a race of people might be propagated by this man, as different from other men as an African is from an Englishman; and that if this should have happened in any former age, and the accidental original have been forgotten, there would be the same objections against their being derived from the same common stock with others: it must therefore be admitted possible, that the differences now subsisting between one part of mankind and another may have been produced by some such accidental cause, long after the earth has been peopled by one common progenitor."

PORE, in anatomy, a little interstice or space between the parts of the skin, serving for perspiration.

PORELLA, in botany; a genus of the natural order of musci, belonging to the cryptogamia class of plants. The antheræ are multilocular, full of natural pores, with an operculum; there is no calyptra, nor pedicle; the capsules contain a powder like those of the other mosses; and their manner of shedding this powder is not by separating into two parts, like those of the selago and lycopodium, but by opening into several holes on all sides.

3 D

POREN.

Porch

||

Porella.

Porentru,
Porism.

PORENTRU, is a town of Switzerland, in Elsgaw, and capital of the territory of the bishop of Basle. It has a good castle, where he resides. It has in it, however, nothing else worth taking notice of, except the cathedral. The bishop is a prince of the empire. It is seated on the river Halle, near mount Jura, 22 miles south of Basle. E. Long. 7. 2. N. Lat. 47. 34.

PORISM, in geometry, is a name given by the ancient geometers to two classes of mathematical propositions. Euclid gives this name to propositions which are involved in others which he is professedly investigating, and which, although not his principal object, are yet obtained along with it, as is expressed by their name *porismata*, "acquisitions." Such propositions are now called *corollaries*. But he gives the same name, by way of eminence, to a particular class of propositions which he collected in the course of his researches, and selected from among many others on account of their great subserviency to the business of geometrical investigation in general. These propositions were so named by him, either from the way in which he discovered them, while he was investigating something else, by which means they might be considered as gains or acquisitions, or from their utility in acquiring farther knowledge as steps in the investigation. In this sense they are *porismata*; for *poris* signifies both to investigate and to acquire by investigation. These propositions formed a collection, which was familiarly known to the ancient geometers by the name of Euclid's *porisms*; and Pappus of Alexandria says, that it was a most ingenious collection of many things conducive to the analysis or solution of the most difficult problems, and which afforded great delight to those who were able to understand and to investigate them.

Unfortunately for mathematical science, however, this valuable collection is now lost, and it still remains a doubtful question in what manner the ancients conducted their researches upon this curious subject. We have, however, reason to believe that their method was excellent both in principle and extent, for their analysis led them to many profound discoveries, and was restricted by the severest logic. The only account we have of this class of geometrical propositions, is in a fragment of Pappus, in which he attempts a general definition of them as a set of mathematical propositions distinguishable in kind from all others; but of this distinction nothing remains, except a criticism on a definition of them given by some geometers, and with which he finds fault, as defining them only by an accidental circumstance, "*Porisma est quod deficit hypothese a theoremate locali.*"

Pappus then proceeds to give an account of Euclid's porisms; but the enunciations are so extremely defective, at the same time that they refer to a figure now lost, that Dr Halley confesses the fragment in question to be beyond his comprehension.

The high encomiums given by Pappus to these propositions have excited the curiosity of the greatest geometers of modern times, who have attempted to discover their nature and manner of investigation. M. Fermat, a French mathematician of the last century, attaching himself to the definition which Pappus criticises, published an introduction (for this is its modest title) to this subject, which many others tried to elucidate in vain. At length Dr Simson of Glasgow, by patient inquiry and some lucky thoughts, obtained

restoration of the porisms of Euclid, which has all the appearance of being just. It precisely corresponds to Pappus's description of them. All the lemmas which Pappus has given for the better understanding of Euclid's propositions are equally applicable to those of Dr Simson, which are found to differ from local theorems precisely as Pappus affirms those of Euclid to have done. They require a particular mode of analysis, and are of immense service in geometrical investigation; on which account they may justly claim our attention.

While Dr Simson was employed in this inquiry, he carried on a correspondence upon the subject with the late Dr M. Stewart, professor of mathematics in the university of Edinburgh; who, besides entering into Dr Simson's views, and communicating to him many curious porisms, pursued the same subject in a new and very different direction. He published the result of his inquiries in 1746, under the title of General Theorems, not caring to give them any other name, lest he might appear to anticipate the labours of his friend and former preceptor. The greater part of the propositions contained in that work are porisms, but without demonstrations; therefore, whoever wishes to investigate one of the most curious subjects in geometry, will there find abundance of materials, and an ample field for discussion.

Dr Simson defines a porism to be "a proposition, in which it is proposed to demonstrate, that one or more things are given, between which, and every one of innumerable other things not given, but assumed according to a given law, a certain relation described in the proposition is shown to take place."

This definition is not a little obscure, but will be plainer if expressed thus: "A porism is a proposition affirming the possibility of finding such conditions as will render a certain problem indeterminate, or capable of innumerable solutions." This definition agrees with Pappus's idea of these propositions, so far at least as they can be understood from the fragment already mentioned; for the propositions here defined, like those which he describes, are, strictly speaking, neither theorems nor problems, but of an intermediate nature between both; for they neither simply enunciate a truth to be demonstrated, nor propose a question to be resolved, but are affirmations of a truth in which the determination of an unknown quantity is involved. In as far, therefore, as they assert that a certain problem may become indeterminate, they are of the nature of theorems; and, in as far as they seek to discover the conditions by which that is brought about, they are of the nature of problems.

We shall endeavour to make our readers understand this subject distinctly, by considering them in the way in which it is probable they occurred to the ancient geometers in the course of their researches: this will at the same time show the nature of the analysis peculiar to them, and their great use in the solution of problems.

It appears to be certain, that it has been the solution of problems which, in all states of the mathematical sciences, has led to the discovery of geometrical truths; the first mathematical inquiries, in particular, must have occurred in the form of questions, where something was given, and something required to be done; and by the reasoning

Porism.

Porism.

reasoning necessary to answer these questions, or to discover the relation between the things given and those to be found, many truths were suggested, which came afterwards to be the subject of separate demonstrations.

The number of these was the greater, because the ancient geometers always undertook the solution of problems, with a scrupulous and minute attention, inasmuch that they would scarcely suffer any of the collateral truths to escape their observation.

Now, as this cautious manner of proceeding gave an opportunity of laying hold of every collateral truth connected with the main object of inquiry, these geometers soon perceived, that there were many problems which in certain cases would admit of no solution whatever, in consequence of a particular relation taking place among the quantities which were given. Such problems were said to become impossible: and it was soon perceived, that this always happened when one of the conditions of the problem was inconsistent with the rest. Thus, when it was required to divide a line, so that the rectangle contained by its segments might be equal to a given space, it is evident that this was possible only when the given space was less than the square of half the line; for when it was otherwise, the two conditions defining, the one the magnitude of the line, and the other the rectangle of its segments, were inconsistent with each other. Such cases would occur in the solution of the most simple problems; but if they were more complicated, it must have been remarked, that the constructions would sometimes fail, for a reason directly contrary to that just now assigned. Cases would occur, where the lines, which by their intersection were to determine the thing sought, instead of intersecting each other as they did commonly, or of not meeting at all as in the above mentioned case of impossibility, would coincide with one another entirely, and of course leave the problem unresolved. It would appear to geometers upon a little reflection, that since, in the case of determinate problems, the thing required was determined by the intersection of the two lines already mentioned, that is, by the points common to both; so in the case of their coincidence, as all their parts were in common, every one of these points must give a solution, or, in other words, the solutions must be indefinite in number.

Upon inquiry, it would be found that this proceeded from some condition of the problem having been involved in another, so that, in fact, there was but one, which did not leave a sufficient number of independent conditions to limit the problem to a single or to any determinate number of solutions. It would soon be perceived, that these cases formed very curious propositions of an intermediate nature between problems and theorems; and that they admitted of being enunciated in a manner peculiarly elegant and concise. It was to such propositions that the ancients gave the name of *porisms*. This deduction requires to be illustrated by an example: suppose, therefore, that it were required to resolve the following problem.

Plate
CCCCXIII

A circle ABC (fig. 1.), a straight line DE, and a point F, being given in position, to find a point G in the straight line DE such, that GF, the line drawn from it to the given point, shall be equal to GB, the line drawn from it touching the given circle.

Suppose G to be found, and GB to be drawn touch-

ing the given circle ABC in B, let H be its centre, join HB, and let HD be perpendicular to DE. From D draw DL, touching the circle ABC in L, and join HL; also from the centre G, with the distance GB or GF, describe the circle BKF, meeting HD in the points K and K'. Then HD and DL are given in position and magnitude; and because GB touches the circle ABC, HBG is a right angle; and since G is the centre of the circle BKF, therefore HB touches the circle BKF, and HB² = the rectangle KHK'; which rectangle + DK² = HD², because K'K is bisected in D, therefore HL² + KD² = DH² = HL² + LD²; therefore DK² = DL², and DK = DL; and since DL is given in magnitude, DK is also given, and K is a given point: for the same reason K' is a given point, and the point F being given by hypothesis, the circle BKF is given by position. The point G, the centre of the circle, is therefore given, which was to be found. Hence this construction:

Having drawn HD perpendicular to DE, and DL touching the circle ABC, make DK and DK' each equal to DL, and find G the centre of the circle described through the points KFK'; that is, let FK be joined and bisected at right angles by MN, which meets DE in G, G will be the point required; that is, if GB be drawn touching the circle ABC, and GF to the given point, GB is equal to GF.

The synthetical demonstration is easily derived from the preceding analysis; but it must be remarked, that in some cases this construction fails. For, first, if F fall anywhere in DH, as at F', the line MN becomes parallel to DE, and the point G is nowhere to be found; or, in other words, it is at an infinite distance from D.—This is true in general; but if the given point F coincides with K, then MN evidently coincides with DE; so that, agreeable to a remark already made, every point of the line DE may be taken for G, and will satisfy the conditions of the problem; that is to say, GB will be equal to GK, wherever the point G be taken in the line DE: the same is true if F coincide with K. Thus we have an instance of a problem, and that too a very simple one, which, in general, admits but of one solution; but which, in one particular case, when a certain relation takes place among the things given, becomes indefinite, and admits of innumerable solutions. The proposition which results from this case of the problem is a porism, and may be thus enunciated:

"A circle ABC being given by position, and also a straight line DE, which does not cut the circle, a point K may be found, such, that if G be any point whatever in DE, the straight line drawn from G to the point K shall be equal to the straight line drawn from G touching the given circle ABC."

The problem which follows appears to have led to the discovery of many porisms.

A circle ABC (fig. 2.) and two points D, E, in a diameter of it being given, to find a point F in the circumference of the given circle; from which, if straight lines be drawn to the given points E, D, these straight lines shall have to one another the given ratio of α to β , which is supposed to be that of a greater to a less.—Suppose the problem resolved, and that F is found, so that FE has to FD the given ratio of α to β , produce EF towards B, bisect the angle EFD by FL, and DFB by FM: therefore EL : LD :: EF : FD, that is in a given ratio, and since ED is given, each of the seg-

Porism.

ments EL, LD, is given, and the point L is also given; because DFB is bisected by FM, $EM:MD::EF:FD$, that is, in a given ratio, and therefore M is given. Since DFL is half of DFE, and DFM half of DFB, therefore LFM is half of $(DFE+DFB)$, therefore LFM is a right angle; and since the points L, M, are given, the point F is in the circumference of a circle described upon LM as a diameter, and therefore given in position. Now the point F is also in the circumference of the given circle ABC, therefore it is in the intersection of the two given circumferences, and therefore is found. Hence this construction: Divide ED in L, so that EL may be to LD in the given ratio of α to β , and produce ED also to M, so that EM may be to MD in the same given ratio of α to β ; bisect LM in N, and from the centre N, with the distance NL, describe the semicircle LFM; and the point F, in which it intersects the circle ABC, is the point required.

The synthetical demonstration is easily derived from the preceding analysis. It must, however, be remarked, that the construction fails when the circle LFM falls either wholly within or wholly without the circle ABC, so that the circumferences do not intersect; and in these cases the problem cannot be solved. It is also obvious that the construction will fail in another case, viz. when the two circumferences LFM, ABC, entirely coincide. In this case, it is farther evident, that every point in the circumference ABC will answer the conditions of the problem, which is therefore capable of numberless solutions, and may, as in the former instances, be converted into a porism. We now inquire, therefore, in what circumstances the point L will coincide with A, and also the point M with C, and of consequence the circumference LFM with ABC. If we suppose that they coincide $EA:AD::\alpha:\beta::EC:CD$, and $EA:EC::AD:CD$, or by conversion $EA:AC::AD:CD-AD::AD:2DO$, O being the centre of the circle ABC; therefore, also, $EA:AO::AD:DO$, and by composition $EO:AO::AO:DO$, therefore $EO \times OD = AO^2$. Hence, if the given points E and D (fig. 3.) be so situated, that $EO \times OD = AO^2$, and at the same time $\alpha:\beta::EA:AD::EC:CD$, the problem admits of numberless solutions; and if either of the points D or E be given, the other point, and also the ratio which will render the problem indeterminate, may be found. Hence we have this porism:

“A circle ABC, and also a point D being given, another point E may be found, such that the two lines inflected from these points to any point in the circumference ABC, shall have to each other a given ratio, which ratio is also to be found.” Hence also we have an example of the derivation of porisms from one another, for the circle ABC, and the points D and E remaining as before (fig. 3.), if, through D, we draw any line whatever HDB, meeting the circle in B and H; and if the lines EB, EH, be also drawn, these lines will cut off equal circumferences BF, HG. Let FC be drawn, and it is plain from the foregoing analysis, that the angles DFC, CFB, are equal; therefore if OG, OB, be drawn, the angles BOC, COG, are also equal; and consequently the angles DOB, DOG. In the same manner, by joining AB, the angle DBE being bisected by BA, it is evident that the angle AOF

is equal to AOH, and therefore the angle FOB to HOG, that is, the arch FB to the arch HG. This proposition appears to have been the last but one in the third book of Euclid's Porisms, and the manner of its enunciation in the porismatic form is obvious.

The preceding proposition also affords an illustration of the remark, that the conditions of a problem are involved in one another in the porismatic or indefinite case; for here several independent conditions are laid down, by the help of which the problem is to be resolved. Two points D and E are given, from which two lines are to be inflected, and a circumference ABC, in which these lines are to meet, as also a ratio which these lines are to have to each other. Now these conditions are all independent on one another, so that any one may be changed without any change whatever in the rest. This is true in general; but yet in one case, viz. when the points are so related to one another that their rectangle under their distances from the centre is equal to the square of the radius of the circle; it follows from the preceding analysis, that the ratio of the inflected lines is no longer a matter of choice, but a necessary consequence of this disposition of the points.

From what has been already said, we may trace the imperfect definition of a porism which Pappus ascribes to the later geometers, viz. that it differs from a local theorem, by wanting the hypothesis assumed in that theorem.—Now, to understand this, it must be observed, that if we take one of the propositions called *loci*, and make the construction of the figure a part of the hypothesis, we get what was called by the ancient geometers a *local theorem*. If, again, in the enunciation of the theorem, that part of the hypothesis which contains the construction be suppressed, the proposition thence arising will be a porism, for it will enunciate a truth, and will require to the full understanding and investigation of that truth, that something should be found, viz. the circumstances in the construction supposed to be omitted.

Thus, when we say, if from two given points E, D, (fig. 3.) two straight lines EF, FD, are inflected to a third point F, so as to be to one another in a given ratio, the point F is in the circumference of a given circle, we have a locus. But when conversely it is said, if a circle ABC, of which the centre is O, be given by position, as also a point E; and if D be taken in the line EO, so that $EO \times OD = AO^2$; and if from E and D the lines EF, DF be inflected to any point of the circumference ABC, the ratio of EF to DF will be given, viz. the same with that of EA to AD, we have a local theorem.

Lastly, when it is said, if a circle ABC be given by position, and also a point E, a point D may be found, such that if EF, FD be inflected from E and D to any point F in the circumference ABC, these lines shall have a given ratio to one another, the proposition becomes a porism, and is the same that has just now been investigated.

Hence it is evident, that the local theorem is changed into a porism, by leaving out what relates to the determination of D, and of the given ratio. But though all propositions formed in this way from the conversion of loci, are porisms, yet all porisms are not formed from the conversion of loci; the first, for instance, of the preceding cannot by conversion be changed into a locus; therefore

Porism.

Place
CCCCXIII

Porism. therefore Fermat's idea of porisms, founded upon this circumstance, could not fail to be imperfect.

To confirm the truth of the preceding theory, it may be added, that professor Dr Stewart, in a paper read a considerable time ago before the Philosophical Society of Edinburgh, defines a porism to be "A proposition affirming the possibility of finding one or more conditions of an indeterminate theorem;" where, by an indeterminate theorem, he meant one which expresses a relation between certain quantities that are determinate and certain others that are indeterminate; a definition which evidently agrees with the explanations which have been here given.

If the idea which we have given of these propositions be just, it follows, that they are to be discovered by considering those cases in which the construction of a problem fails, in consequence of the lines which by their intersection, or the points which by their position, were to determine the problem required, happening to coincide with one another. A porism may therefore be deduced from the problem to which it belongs, just as propositions concerning the *maxima* and *minima* of quantities are deduced from the problems of which they form limitations; and such is the most natural and obvious analysis of which this class of propositions admits.

The following porism is the first of Euclid's, and the first also which was restored. It is given here to exemplify the advantage which, in investigations of this kind, may be derived from employing the *law of continuity* in its utmost extent, and pursuing porisms to those extreme cases where the indeterminate magnitudes increase *ad infinitum*.

This porism may be considered as having occurred in the solution of the following problem: Two points A, B, (fig. 4.) and also three straight lines DE, FK, KL, being given in position, together with two points H and M in two of these lines, to intersect from A and B to a point in the third, two lines that shall cut off from KF and KL two segments, adjacent to the given points H and M, having to one another the given ratio of α to β . Now, to find whether a porism be connected with this problem, suppose that there is, and that the following proposition is true. Two points A and B, and two straight lines DE, FK, being given in position, and also a point H in one of them, a line LK may be found, and also a point in it M, both given in position, such that AE and BE intersected from the points A and B to any point whatever of the line DE, shall cut off from the other lines FK and LK segments HG and MN adjacent to the given points H and M, having to one another the given ratio of α to β .

First, let AE, BE, be intersected to the point E', so that AE' may be parallel to FK, then shall E'B be parallel to KL, the line to be found; for if it be not parallel to KL, the point of their intersection must be at a finite distance from the point M, and therefore making as β to α ; so this distance to a fourth proportional, the distance from H at which AE' intersects FK, will be equal to that fourth proportional. But AE' does not intersect FK, for they are parallel by construction; therefore BE' cannot intersect KL, which is therefore parallel to BE', a line given in position. Again, let AE'', BE'', be intersected to E'', so that AE'' may pass through the given point H: then it is plain that BE''

must pass through the point to be found M; for if not, it may be demonstrated just as above, that AE'' does not pass through H, contrary to the supposition. The point to be found is therefore in the line E'B, which is given in position. Now if from E there be drawn EP parallel to AE', and ES parallel to BE', BS:SE::BL

$$:LN = \frac{SE \times BL}{BS}, \text{ and } AP:PE::AF:FG = \frac{PE \times AF}{AP};$$

$$\text{therefore } FG:LN::\frac{PE \times AF}{AP}:\frac{SE \times BL}{BS}::PE \times AF$$

$\times BS:SE \times BL \times AP$; wherefore the ratio of FG to LN is compounded of the ratios of AF to BL, PE to ES, and BS to AP; but PE:SE::AE':BE', and BS:AP::DB:DA for DB:BS::DE':E'E::DA:AP; therefore the ratio of FG to LN is compounded of the ratios of AF' to BL, AE' to BE', and DB to DA. In like manner, because E'' is a point in the line DE and AE'', BE'' are intersected to it, the ratio of FH to LM is compounded of the same ratios of AF to BL, AE' to BE', and DB to DA; therefore FH:LM::FG:NL (and consequently)::HG:MN; but the ratio of HG to MN is given, being the same as that of α to β ; the ratio of FH to LM is therefore also given, and FH being given, LM is given in magnitude. Now LM is parallel to BE', a line given in position; therefore M is in a line QM, parallel to AB, and given in position; therefore the point M, and also the line KLM, drawn through it parallel to BE', are given in position, which were to be found. Hence this construction: From A draw AE' parallel to FK, so as to meet DE in E'; join BE', and take in it BQ, so that $\alpha:\beta::HF:BQ$, and through Q draw QM parallel to AB. Let HA be drawn, and produced till it meet DE in E'', and draw BE'', meeting QM in M; through M draw KML parallel to BE', then is KML the line and M the point which were to be found. There are two lines which will answer the conditions of this porism; for if in QB, produced on the other side of B, there be taken Bq=BQ, and if qm be drawn parallel to AB, cutting MB in m; and if mn be drawn parallel to BQ, the part mn, cut off by EB produced, will be equal to MN, and have to HG the ratio required. It is plain, that whatever be the ratio of α to β , and whatever be the magnitude of FH, if the other things given remain the same, the lines found will be all parallel to BE'. But if the ratio of α to β remain the same likewise, and if only the point H vary, the position of KL will remain the same, and the point M will vary.

Another general remark which may be made on the analysis of porisms is, that it often happens, as in the last example, that the magnitudes required may all, or a part of them, be found by considering the extreme cases; but for the discovery of the relation between them, and the indefinite magnitudes, we must have recourse to the hypothesis of the porism in its most general or indefinite form; and must endeavour so to conduct the reasoning, that the indefinite magnitudes may at length totally disappear, and leave a proposition asserting the relation between determinate magnitudes only.

For this purpose Dr Simson frequently employs two statements of the general hypothesis, which he compares together. As for instance, in his analysis of the last po-

Po ifm

risin, he assumes not only E, any point in the line DE, but also another point O, anywhere in the same line, to both of which he supposes lines to be inflected from the points A, B. This double statement, however, cannot be made without rendering the investigation long and complicated; nor is it even necessary, for it may be avoided by having recourse to simpler *porisms*, or to *loci*, or to propositions of the *data*. The following porism is given as an example where this is done with some difficulty, but with considerable advantage both with regard to the simplicity and shortness of the demonstration. It will be proper to premise the following lemma.

Plate
CCCCXIII

Let AB (fig. 7.) be a straight line, and D, L any two points in it, one of which D is between A and B; let CL be any straight line. $\frac{LB}{CL} \cdot AD^2 + \frac{LA}{CL} \cdot BD^2 =$

$\frac{LB}{CL} \cdot AL^2 + \frac{LA}{CL} \cdot BL^2 + \frac{AB}{CL} \cdot DL^2$. Place CL perpen-

dicular to AB, and through the points A, C, B, describe a circle; and let CL meet it again in E, and join AE, BE. Draw DG parallel to CE, meeting AE and BE in H and G. Draw EK parallel to AB.

$CL : LB :: (LA : LE ::) LA^2 : LA \times LE = \frac{LB}{CL} \cdot LA^2$

$CL : LA :: (LB : LE ::) LB^2 : LB \times LE = \frac{LA}{CL} \cdot LB^2$.

Now $CL : LB :: LA : LE :: (EK) LD : KH$, and $CL : LA :: LB : LE :: (EK) LD : KG$; therefore, (V. 24.) $CL : AB :: (LD : GH ::) LD^2 : EK \times GH =$

$\frac{AB}{CL} \cdot LD^2$; therefore $\frac{LB}{CL} \cdot LA^2 + \frac{LA}{CL} \cdot LB^2 + \frac{AB}{CL} \cdot LD^2 = AB \times LE + EK \times GH$. Again, $CL : LA ::$

$(LB : LE ::) DB : DG ::) DB^2 : DB \times DG = \frac{LA}{CL} \cdot DB^2$, and $CL : LB :: (LA : LE ::) DA : DH ::)$

$DA^2 : DA \times DH = \frac{LB}{CL} \cdot DA^2$; therefore $\frac{LB}{CL} \cdot DA^2 +$

$\frac{LA}{CL} \cdot DB^2 = AD \times DH + DB \times DG = AB \times LE + EK \times$

GH ; wherefore $\frac{LB}{CL} \cdot DA^2 + \frac{LA}{CL} \cdot DB^2 = \frac{LB}{CL} \cdot LA^2 +$

$\frac{LA}{CL} \cdot LB^2 + \frac{AB}{CL} \cdot LD^2$. Q. E. D.

Let there be three straight lines AB, AC, CB given in position (fig. 5.); and from any point whatever in one of them, as D, let perpendiculars be drawn to the other two, as DF, DE, a point G may be found, such, that if GD be drawn from it to the point D, the square of that line shall have a given ratio to the sum of the squares of the perpendiculars DF and DE, which ratio is to be found.

Draw AH, BK perpendicular to BC and AC; and in AB take L, so that $AL : LB :: AH^2 : BK^2 :: AC^2 : CB^2$. The point L is therefore given; and if N be taken, so as to have to AL the same ratio that AB has to AH, N will be given in magnitude. Also, since $AH^2 : BK^2 :: AL : LB$, and $AH^2 : AB^2 :: AL : N$, *ex equo* $BK^2 : AB^2 :: LB : N$. Draw LO, LM perpendicular to AC, CB; LO, LM are therefore given in magnitude. Now, because $AB^2 : BK^2 ::$

$AD^2 : DF^2$, $N : LB :: AD^2 : DF^2$, and $DF^2 = \frac{LB}{N}$

$\cdot AD^2$; and for the same reason $DE^2 = \frac{AL}{N} \cdot BD^2$; but,

Porism.

by the preceding lemma, $\frac{LB}{N} \cdot AD^2 + \frac{AL}{N} \cdot BD^2 = \frac{LB}{N}$

$\cdot AL^2 + \frac{AL}{N} \cdot BL^2 + \frac{AB}{N} \cdot DL^2$; that is, $DE^2 + DF^2 =$

$LO^2 + LM^2 + \frac{AB}{N} \cdot DL^2$. Join LG then by hypothe-

sis $LO^2 + LM^2$, as to LG^2 , the same ratio as $DF^2 +$

DE^2 has to DG^2 ; let it be that of R to N, then $LO^2 +$

$LM^2 = \frac{R}{N} \cdot LG^2$; and therefore $DE^2 + DF^2 = \frac{R}{N} \cdot LG^2 +$

$\frac{AB}{N} \cdot DL^2$; but $DE^2 + DF^2 = \frac{R}{N} \cdot DG^2$; therefore, $\frac{R}{N}$

$\cdot LG^2 + \frac{AB}{N} \cdot DL^2 = \frac{R}{N} \cdot DG^2$, and $\frac{AB}{N} \cdot DL^2 = \frac{R}{N} (DG^2 -$

$LG^2)$; therefore $DG^2 - LG^2$ has to DL^2 a constant

ratio, viz. that of AB to R. The angle DLG is there-

fore a right angle, and the ratio of AB to R that of

equality, otherwise LD would be given in magnitude,

contrary to the supposition. LG is therefore given in

position: and since $R : N :: AB : N :: LO^2 + LM^2 :$

LG^2 ; therefore the square of LG, and consequently

LG, is given in magnitude. The point G is there-

fore given, and also the ratio of $DE^2 + DF^2$ to DG^2 ,

which is the same with that of AB to N.

The construction easily follows from the analysis, but

it may be rendered more simple; for since $AH^2 : AB^2$

$:: AL : N$, and $BK^2 : AB^2 :: BL : N$; therefore AH^2

$+ BK^2 : AB^2 :: AB : N$. Likewise, if AG, BG, be

joined, $AB : N :: AH^2 : AG^2$, and $AB : N :: BK^2 :$

BG^2 ; wherefore $AB : N :: AK^2 + BK^2 : AG^2 + BG^2$

and $AG^2 + BG^2 = AB^2$; therefore the angle AGB is

a right one, and $AL : LG :: LG : LB$. If therefore AB

be divided in L, so that $AL : LB :: AH^2 : BK^2$; and

if LG, a mean proportional between AL and LB, be

placed perpendicular to AB, G will be the point re-

quired.

The step in the analysis, by which a second intro-

duction of the general hypothesis is avoided, is that in

which the angle GLD is concluded to be a right angle;

which follows from $DG^2 - GL^2$, having a given ratio to

LD^2 , at the same time that LD is of no determinate mag-

nitude. For, if possible, let GLD be obtuse (fig. 6.),

and let the perpendicular from G to AB meet it in V,

therefore V is given: and since $GD - LG^2 = LD^2 +$

$2DL \times LV$; therefore, by the supposition, $LD^2 + 2DL$

$\times LV$ must have a given ratio to LD^2 ; therefore the

ratio of LD^2 to $DL \times VL$, that is, of LD to VL, is

given, so that VL being given in magnitude, LD is al-

so given. But this is contrary to the supposition; for

LD is indefinite by hypothesis, and therefore GLD

cannot be obtuse, nor any other than a right angle.

The conclusion here drawn immediately from the inde-

termination of LD would be deduced, according to

Dr Simson's method, by assuming another point D'

any how, and from the supposition that $GD'^2 - GL^2 :$

$LD'^2 :: GD - GL^2 : LD^2$, it would easily appear that

GLD must be a right angle, and the ratio that of equal-

ity.

These porisms facilitate the solution of the general

problems from which they are derived. For example, let

three straight lines AB, AC, BC (fig. 5.), be given in

posi-

PORISM.

Fig. 1.

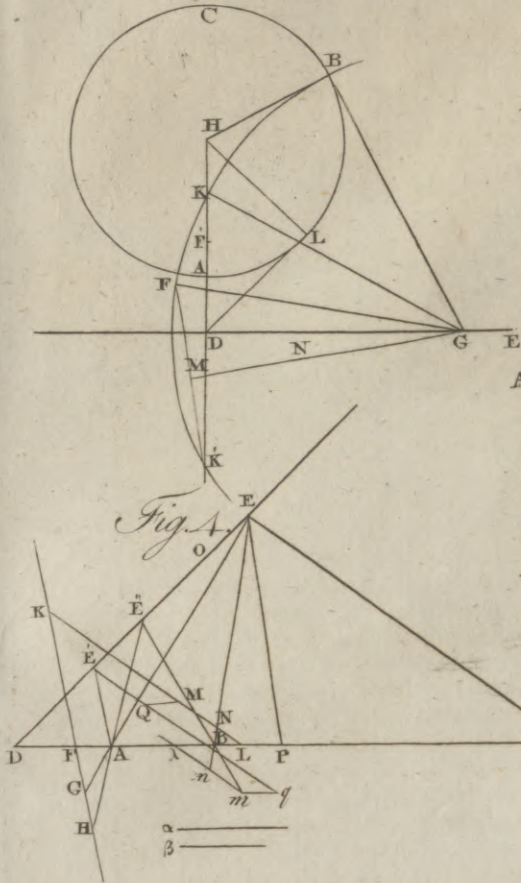


Fig. 5.

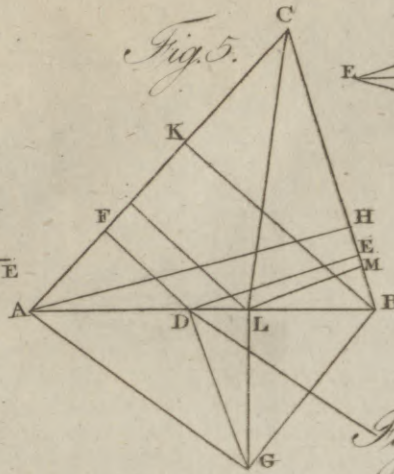


Fig. 3.

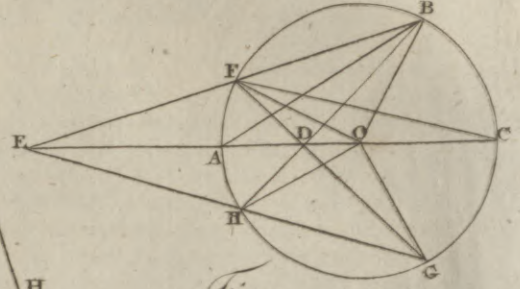


Fig. 7.

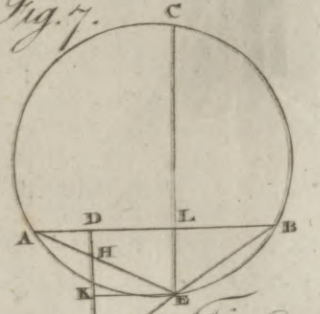


Fig. 2.

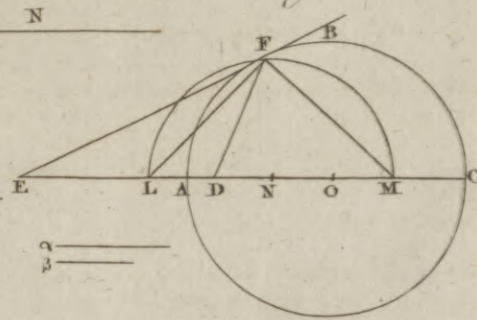
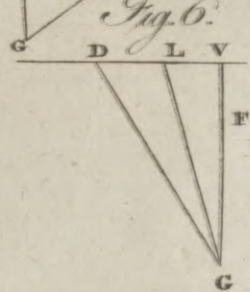


Fig. 6.



Machine for draining Ponds without disturbing the Mud.

Fig. 2.

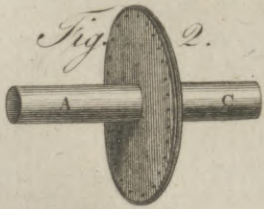
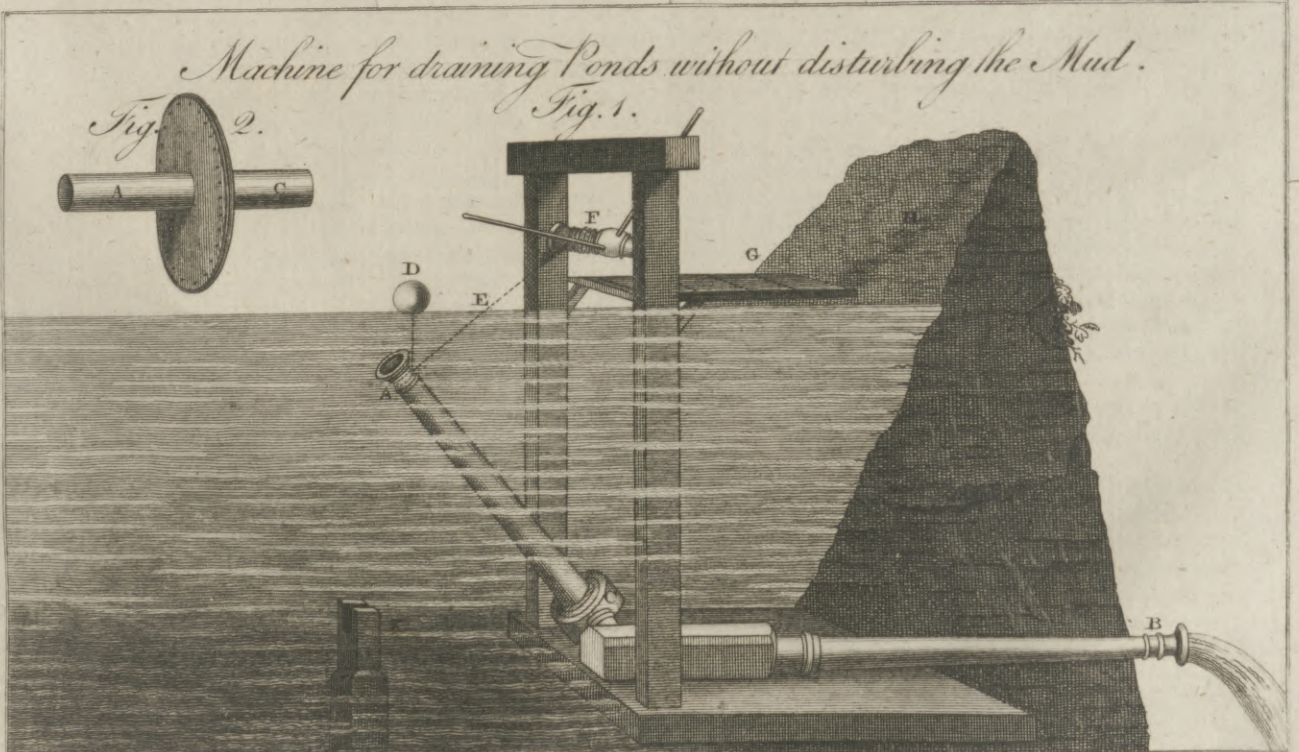


Fig. 1.



Porism.

position, and also a point R, to find a point D in one of the given lines, so that DE and DF being drawn perpendicular to BC, AC, and DR, joined; $DE^2 + DF^2$ may have to DR^2 a given ratio. It is plain, that having found G, the problem would be nothing more than to find D, such that the ratio of GD^2 to DR^2 , and therefore that of GD to DR, might be given, the point D being in the circumference of a given circle, as is well known to geometers.

The same porism also assists in the solution of another problem. For if it were required to find D such that $DE^2 + DF^2$ might be a given space; having found G, DG^2 would have to $DE^2 + DF^2$ a given ratio, and DG would therefore be given; whence the solution is obvious.

The connection of this porism with the impossible case of the problem is evident; the point L being that from which, if perpendiculars be drawn to AC and CB, the sum of their squares is the least possible. For since $DF^2 + DE^2 : DG^2 :: LO^2 + LM^2 : LG^2$; and since LG is less than DG, $LO^2 + LM^2$ must be less than $DF^2 + DE^2$. It is evident from what has now appeared, that in some instances at least there is a close connection between these propositions and the *maxima* or *minima*, and of consequence the impossible cases of problems. The nature of this connection requires to be farther investigated, and is the more interesting because the transition from the indefinite to the impossible case seems to be made with wonderful rapidity. Thus in the first proposition, though there be not properly speaking an impossible case, but only one where the point to be found goes off *ad infinitum*, it may be remarked, that if the given point F be anywhere out of the line HD (fig. 1.), the problem of drawing GB equal to GF is always possible, and admits of just one solution; but if F be in DH, the problem admits of no solution at all, the point being then at an infinite distance, and therefore impossible to be assigned. There is, however, this exception, that if the given point be at K in this same line, DH is determined by making DK equal to DL. Then every point in the line DE gives a solution, and may be taken for the point G. Here therefore the case of numberless solutions, and of no solution at all, are as it were *conterminal*, and so close to one another, that if the given point be at K the problem is indefinite; but if it remove ever so little from K, remaining at the same time in the line DH, the problem cannot be resolved. This affinity might have been determined *a priori*: for it is, as we have seen, a general principle, that a problem is converted into a porism when one or when two of the conditions of it necessarily involve in them some one of the rest. Suppose, then, that two of the conditions are exactly in that state which determines the third; then while they remain fixed or given, should that third one vary or differ ever so little from the state required by the other two, a contradiction will ensue: therefore if, in the hypothesis of a problem, the conditions be so related to one another as to render it indeterminate, a porism is produced; but if, of the conditions thus related to one another, some one be supposed to vary, while the others continue the same, an absurdity follows, and the problem becomes impossible. Wherever, therefore, any problem admits both of an indeterminate and an impossible case, it is certain, that these cases are nearly related to one

another, and that some of the conditions by which they are produced are common to both." It is supposed above, that *two* of the conditions of a problem involve in them a third; and wherever that happens, the conclusion which has been deduced will invariably take place. But a porism may in some cases be so simple as to arise from the mere coincidence of *one* condition with another, though in no case whatever any inconsistency can take place between them. There are, however, comparatively few porisms so simple in their origin, or that arise from problems where the conditions are but little complicated; for it usually happens that a problem which can become indefinite may also become impossible; and if so, the connection already explained never fails to take place.

Another species of impossibility may frequently arise from the porismatic case of a problem which will affect in some measure the application of geometry to astronomy, or any of the sciences depending on experiment or observation. For when a problem is to be resolved by help of data furnished by experiment or observation, the first thing to be considered is, whether the data so obtained be sufficient for determining the thing sought; and in this a very erroneous judgment may be formed, if we rest satisfied with a general view of the subject; for tho' the problem may in general be resolved from the data with which we are provided, yet these data may be so related to one another in the case under consideration, that the problem will become indeterminate, and instead of one solution will admit of an indefinite number. This we have already found to be the case in the foregoing propositions. Such cases may not indeed occur in any of the practical applications of geometry; but there is one of the same kind which has actually occurred in astronomy. Sir Isaac Newton, in his *Principia*, has considered a small part of the orbit of a comet as a straight line described with an uniform motion. From this hypothesis, by means of four observations made at proper intervals of time, the determination of the path of the comet is reduced to this geometrical problem: Four straight lines being given in position, it is required to draw a fifth line across them, so as to be cut by them into three parts, having given ratios to one another. Now this problem had been constructed by Dr Wallis and Sir Christopher Wren, and also in three different ways by Sir Isaac himself in different parts of his works; yet none of these geometers observed that there was a particular situation of the lines in which the problem admitted of innumerable solutions: and this happens to be the very case in which the problem is applicable to the determination of the comet's path, as was first discovered by the Abbé Boscovich, who was led to it by finding, that in this way he could never determine the path of a comet with any degree of certainty.

Besides the geometrical there is also an algebraical analysis belonging to porisms; which, however, does not belong to this place, because we give this account of them merely as an article of ancient geometry; and the ancients never employed algebra in their investigations. Mr Playfair, professor of mathematics in the university of Edinburgh, has written a paper on the origin and geometrical investigation of porisms, which is published in the third volume of the *Transactions* of the Royal Society of Edinburgh, from which this account of the

Pork,
Porlock.

subject is taken. He has there promised a second part to his paper, in which the algebraical investigation of porisms is to be considered. This will no doubt throw considerable light upon the subject, as we may readily judge from that gentleman's known abilities, and from the specimen he has already given us in the first part.

PORK, the flesh of swine killed for the purposes of food. See SUS.

The hog is the only domestic animal that we know of no use to man when alive, and therefore seems properly designed for food. Besides, as loathsome and ugly to every human eye, it is killed without reluctance. The Pythagoreans, whether to preserve health, or on account of compassion, generally forbade the use of animal food; and yet it is alleged that Pythagoras reserved the use of hog's flesh for himself. The Jews, the Egyptians, &c. and other inhabitants of warm countries, and all the Mahometans at present, reject the use of pork. It is difficult to find a satisfactory reason for this, or for the precept given to the Jews respecting it, tho' unquestionably there was some good one for it. The Greeks gave great commendations to this food; and Galen, though indeed that is suspected to be from a particular fondness, is everywhere full of it. The Romans considered it as one of their delicacies; and if some of the inhabitants of the northern climates have taken an aversion to it, that probably arose from the uncultivated state of their country not being able to rear it. Pork is of a very tender structure; increased perhaps from a peculiarity in its economy, viz. taking on fat more readily than any other animal. Pork is a white meat even in its adult state, and then gives out a jelly in very great quantity. On account of its little perspirability and tenderness it is very nutritious, and was given for that intention to the *athletæ*. With regard to its alkalescency, no proper experiments have yet been made; but as it is of a gelatinous and succulent nature, it is probably less so than many others. Upon the whole, it appears to be a very valuable nutriment; and the reason is not very obvious why it was in some countries forbid. It is said that this animal is apt to be diseased; but why were not inconveniences felt on that account in Greece? Again, it has been alleged, that as Palestine would not rear these animals, and as the Jews had learned the use of them in Egypt, it was necessary they should have a precept to avoid them. But the Egyptians themselves did not use this meat; and this religious precept, indeed, as well as many others, seems to have been borrowed from them. Possibly, as pork is not very perspirable, it might increase the leprosy, which was said to be epidemic in Palestine; though this is far from being certain.

PORLOCK, in the county of Somerset in England, is a small sea-port town six miles west from Minehead. This whole parish, including hamlets, contains about 110 houses, and nearly 600 inhabitants. The situation of the town is very romantic, being nearly surrounded on all sides, except toward the sea, by steep and lofty hills, intersected by deep vales and hollow glens. Some of the hills are beautifully wooded, and contain numbers of wild deer. The valleys are very deep and picturesque; the sides being steep, scarred with wild rocks, and patched with woods and forest shrubs. Some of them are well cultivated and studded with villages or single farms and cottages, although agriculture here is very imperfectly understood.

Most of the roads and fields are so steep, that no carriages of any kind can be used; all the crops are therefore carried in with crooks on horses, and the manure in wooden pots called *acessels*. Many of the poor are employed in spinning yarn for the Dunster manufactory. W. Long. 3. 32. N. Lat. 51. 14.

PORO. See CALAURIA.

PORPESSE, in ichthyology. See DELPHINUS.

PORPHYRIUS, a famous Platonic philosopher, was born at Tyre in 233, in the reign of Alexander Severus. He was the disciple of Longinus, and became the ornament of his school at Athens; from thence he went to Rome, and attended Plotinus, with whom he lived six years. After Plotinus's death he taught philosophy at Rome with great applause; and became well skilled in polite literature, geography, astronomy, and music. He lived till the end of the third century, and died in the reign of Dioclesian. There are still extant his book on the Categories of Aristotle; a Treatise on Abstinence from Flesh; and several other pieces in Greek. He also composed a large treatise against the Christian religion, which is lost. That work was answered by Methodius bishop of Tyre, and also by Eusebius, Apollinarius, St Augustin, St Jerome, St Cyril, and Theodoret. The emperor Theodosius the Great caused Porphyrius's book to be burned in 338. Those of his works that are still extant were printed at Cambridge in 1655, 8vo, with a Latin version.

"Porphyrius (says Dr Enfield) was, it must be owned, a writer of deep erudition; and had his judgment and integrity been equal to his learning, he would have deserved a distinguished place among the ancients. But neither the splendor of his diction, nor the variety of his reading, can atone for the credulity or the dishonesty which filled the narrative parts of his works with so many extravagant tales, or interest the judicious reader in the abstruse subtleties and mystical flights of his philosophical writings."

PORPHYRY, a genus of stones belonging to the order of saxa. It is found of several different colours, as green, deep red, purple, black, dark-brown, and grey. Under the name of *porphyry*, Mr Kirwan and M. de Saussure include those stones which contain either felt-spar, schoerl, quartz, or mica, with other species of crystallized stone on a siliceous or calcareous ground. There are a great many different kinds. M. Ferber describes 20 varieties under four species, but in general it is considered with relation to its ground, which is met with of the colours already mentioned. When the ground is of jasper, the porphyry is commonly very hard; the red generally contains felt-spar in small white dots or specks; and frequently, together with these, black spots of schoerl. The green is often magnetic, and is either a jasper or schoerl, with spots of quartz. Sometimes a porphyry of one colour contains a fragment of another of a different colour. Those that have chert for their ground are fusible *per se*. The calcareous porphyry consists of quartz, felt-spar, and mica, in separate grains, united by a calcareous cement; and, lastly, the micaceous porphyry consists of a greenish grey micaceous ground, in which red felt-spar and greenish soap-rock are inserted.

The porphyry of the ancients is a most elegant mass of an extremely firm and compact structure, remarkably heavy, and of a fine strong purple, variegated more or less

Poro
||
Porphyry

Cullen's
Mat. Med.

Porphyry. less with pale red and white; its purple is of all degrees, from the claret-colour to that of the violet; and its variegations are rarely disposed in veins, but spots, sometimes very small, and at others running into large blotches. It is less fine than many of the ordinary marbles; but it excels them all in hardness, and is capable of a most elegant polish. It is still found in immense strata in Egypt. The hard red-lead coloured porphyry, variegated with black, white, and green, is a most beautiful and valuable substance. It has the hardness and all the other characters of the oriental porphyry; and even greatly excels it in brightness, and in the beauty and variegation of its colours. It is found in great plenty in the island of Minorca; and is well worth importing, being greatly superior to all the Italian marbles. The hard, pale-red porphyry, variegated with black, white, and green, is of a pale flesh-colour; often approaching to white. It is variegated in blotches from half an inch to an inch broad. It takes a high polish, and emulates all the qualities of the oriental porphyry. It is found in immense strata in Arabia Petraea, and in the Upper Egypt; and in separate nodules in Germany, England, and Ireland.

Ficoroni takes notice of two exquisitely fine columns of black porphyry in a church at Rome. In Egypt there are three celebrated obelisks or pillars of porphyry, one near Cairo and two at Alexandria. The French call them *aguglias*, and in England they are called *Cleopatra's needles*.

The art of cutting porphyry, practised by the ancients, appears now to be lost. Indeed it is difficult to conceive what tools they used for fashioning those huge columns and other porphyry works in some of the ancient buildings in Rome. One of the most considerable of these, still entire, is a tomb of Constantia, the emperor Constantine's daughter. It is in the church of St Agnes, and is commonly called *the tomb of Bacchus*. In the palace of the Thuilleries there is also a bust of Apollo and of twelve emperors, all in porphyry. Some ancient pieces seem to have been wrought with the chisel, others with the saw, others with wheels, and others gradually ground down with emery. Yet modern tools will scarce touch porphyry. Dr Lister therefore thinks*, that the ancients had the secret of tempering steel better than we; and not, as some imagine, that they had the art of softening the porphyry; though it is probable that time and air have contributed to increase its hardness. Mr Addison says, he saw a workman at Rome cutting porphyry; but his advances were extremely slow and almost insensible. The Italian sculptors work the pieces of old porphyry columns still remaining (for the porphyry quarries are long since lost) with a brass saw without teeth. With this saw, emery, and water, they rub and wear the stone with infinite patience. Many persons have endeavoured to retrieve the ancient art, and particularly Leon Baptista Alberti; who, searching for the necessary materials for temper, says, he found goats blood the best of any: but even this availed not much; for in working with chisels tempered with it, sparks of fire came much more plentifully than pieces of the stone. The sculptors were thus, however, able to make a flat or oval form; but could never attain to any thing like a figure.

In the year 1555, Cosmo de Medicis is said to have distilled a water from certain herbs, with which his sculp-

tor Francesco Tadda gave his tools such an admirable hardness and so fine a temper, that he performed some very exquisite works with them; particularly our Saviour's head in demi-relievo, and Cosmo's head and his duchess's. The very hair and beard, how difficult soever, are here well conducted; and there is nothing of the kind superior to it in all the works of the ancients; but the secret appears to have died with him. The French have discovered another mode of cutting porphyry, viz. with an iron saw without teeth, and *grez*, a kind of free stone pulverized, and water. The authors of this invention say, that they could form the whole contour of a column hereby if they had matter to work on. Others have proposed to harden tools so as to cut porphyry, by steeping them in the juice of the plant called *bear's beech* or *brankursine*. See Birch's *Hist. R. S.* vol. i. p. 238. vol. ii. p. 73, &c. Mr Boyle says, that he caused porphyry to be cut by means of emery, steel saws, and water; and observes, that in his time the English workmen were ignorant of the manner of working porphyry, and that none of them would undertake to cut or polish it. See his *Works* abr. vol. i. p. III.

Da Costa supposes, and perhaps with reason, that the method used by the ancients in cutting and engraving porphyry was extremely simple, and that it was performed without the aid of any scientific means that are now lost. He imagines, that, by unwearied diligence, and with numbers of common tools at great expence, they rudely hewed or broke the stone into the intended figure, and by continued application reduced them into more regular designs; and that they completed the work by polishing it with great labour, by the aid of particular hard sands found in Egypt. And he thinks, that in the porphyry quarries there were layers of grit or loose disunited particles, analogous to the porphyry, which they carefully sought for, and used for this work. See *Nat. Hist. of Fossils*, p. 285.

PORPHYRY-Shell, a species of MUREX.

PORPITES, the HAIR-BUTTON STONE, in natural history, a name given by authors to a small species of fossil coral; which is usually of a rounded figure considerably flattened, and striated from the centre every way to the circumference. These are of different sizes and of different colours, as greyish, whitish, brownish, or bluish, and are usually found immersed in stone. See Plate CC.

PORRUM, the LEEK; a species of plants, belonging to the genus of ALLIUM.

PORT, a harbour, river, or haven, formed either by nature or art to receive and shelter shipping from the storms and waves of the open sea.

Artificial ports are those which are either formed by throwing a strong mound or rampire across the harbour's mouth to some island or rock, or erecting two long barriers, which stretch from the land on each side like arms or the horns of a crescent, and nearly inclose the haven; the former of these are called *mole-heads* and the latter *piers*.

PORT, is also a name given on some occasions to the larboard or left side of the ship, as in the following instances. Thus it is said, "the ship heels to port," i. e. stoops or inclines to the larboard-side. "Top the yard to port!" the order to make the larboard extremity of a yard higher than the other. "Port the helm!" the

* *Philosopb. Transact.* N^o 203. or *Lewin's Abrid.* vol. ii. p. 360.

Port.

order to put the helm over to the larboard-side of the vessel. In all these senses this phrase appears intended to prevent any mistakes happening from the similarity of sounds in the words *starboard* and *larboard*, particularly when they relate to the helm, where a misapprehension might be attended with very dangerous consequences.

PORTS, the embrasures or openings in the side of a ship of war, wherein the artillery is ranged in battery upon the decks above and below.

The ports are formed of a sufficient extent to point and fire the cannon, without injuring the ship's side by the recoil; and as it serves no end to enlarge them beyond what is necessary for that purpose, the shipwrights have established certain dimensions, by which they are cut in proportion to the size of the cannon.

The ports are shut in at sea by a sort of hanging-doors called the *port-lids*; which are fastened by hinges to their upper edges, so as to let down when the cannon are drawn into the ship. By this means the water is prevented from entering the lower decks in a turbulent sea. The lower and upper edges of the ports are always parallel to the deck, so that the guns, when levelled in their carriages, are all equally high above the lower extremity of the ports, which is called the *port-cells*.

PORT, is also a strong wine brought from Port-a-port, and also called *Porto* and *Oporto*.

PORT of the Voice, in music, the faculty or habit of making the shakes, passages, and diminutions, in which the beauty of a song or piece of music consists.

PORT-Crayon, a pencil-case, which is usually four or five inches long, and contrived so as that the pencil may slide up and down. Its inside is round, and its outside is sometimes filed into eight sides or faces, on which are drawn the sector-lines; sometimes it is made round both without-side and within, and has its length divided into inches and parts of inches.

PORT-Fire, a composition for setting fire to powder, &c. Port-fires are frequently used by artillery people in preference to matches; and they are distinguished into wet and dry port-fires. The composition of the former is saltpetre four, sulphur one, and meal powder four. When these materials are thoroughly mixed and sifted, the whole is to be moistened with a little linseed oil, and rubbed between the hands till all the oil is imbibed by the composition. The preparation for dry port-fires is saltpetre four, sulphur one, meal powder two, and antimony one. These compositions are driven into small paper cases, to be used whenever necessary.

PORT-aux-Prune, so called by the French, is a country on the coast of Africa, to the north of the island of Madagascar. It is a rich country, and fertile in rice and pastures; it is inhabited only by the negroes, who are an industrious good sort of people, but very superstitious. There are no towns, but several villages, and they have some customs which seem to incline to Judaism.

PORT-Jackson, in New Holland. See *NEW HOLLAND*, n° 7, &c.

PORT-Royal, a sea-port town in the island of Jamaica. It was once a place of the greatest riches and importance in the West Indies: but in 1692 it was destroyed by an earthquake, in 1702 by fire, in 1722 by an inundation

of the sea, and in 1744 it suffered greatly by a hurricane. It is now reduced to three streets, a few lanes, and about 200 houses. It contains the royal navy-yard for heaving down and refitting the king's ships; the navy-hospital, and barracks for a regiment of soldiers. The fortifications, which are very extensive, being in excellent order, and having been lately strengthened with many additional works, it may be said to vie in point of strength with any fortress in the king's dominions. The harbour is one of the best in the world, and 1000 ships may ride therein, secure from every wind that can blow. It is six miles east of Spanishtown, and as much by water south-east of Kingston. W. Long. 76. 40. N. Lat. 18. 0.

PORT-Royal, an island in North America, on the coast of South Carolina, which, with the neighbouring continent, forms one of the most commodious harbours in the British plantations. It is 15 miles in length; and the town on the north shore is called *Beaufort*. W. Long. 80. 10. N. Lat. 31. 40.

PORT-Royal, the name of two monasteries of Cistercian nuns in the diocese of Paris; the one near Chevreuse, at the distance of five leagues from Paris, called *Port-Royal of the Fields*; and the other in Paris, in the suburbs of St James.

The nuns of the former of these monasteries proving refractory, were dispersed; when many ecclesiastics, and others, who were of the same sentiments as these religious, retired to Port-Royal, took apartments there, and printed many books. Hence the name of *Port-Royalists* was given to all their party, and their books were called *books of Port-Royal*: from hence we say the writers of Port-Royal, Messieurs de Port-Royal, and the translations and grammars of Port-Royal.

PORTA, or *Vena PORTA*, in anatomy, a large vein distributed through the liver in the manner of an artery. See *ANATOMY*, n° 96.

PORTA-Angusta (anc. geog.), mentioned only by Ptolemy; a town of the Vaccaei in the Hither Spain; thought by some to be *Torre Quemada*, in Old Castile; by others *Los Valvases*, a village between Burgos and Torre Quemada.

PORTÆ-ROMANÆ (anc. geog.), according to Pliny, Romulus left but three, or at most four, gates of Rome: afterwards, on enlarging the Pomœria, or compass of the city, they amounted to 37.

PORTAL, in architecture, a little gate where there are two gates of a different bigness; also a little square corner of a room cut off from the rest by the wainscot, and forming a short passage into the room. The same name is also sometimes given to a kind of arch of joiners work before a door.

PORTATE, or a *Cross PORTATE*, in heraldry, a cross which does not stand upright, as crosses generally do; but lies across the escutcheon in bend, as if it were carried on a man's shoulder.

PORTCULLICE, in fortification, is an assemblage of several large pieces of wood, joined across one another like a harrow, and each pointed with iron at the bottom. They are sometimes hung over the gate-way of old fortified towns, ready to let down in case of surprise, when the gates could not be shut.

PORTER, a kind of malt-liquor which differs from ale and pale beer, in its being made with high dried malt. See *ALE*, *BEER*, and *BREWING*.

Port

Porter.

Port-
Glasgow
||
Portico.

PORT-GLASGOW. See GLASGOW, n^o 10.
PORTGREVE, or **PORTGRAVE**, was anciently the principal magistrate in ports and other maritime towns. The word is formed from the Saxon *port*, "a port or other town;" and *gerefe*, "a governor."—It is sometimes also written *port-reve*.

Camden observes, that the chief magistrate of London was anciently called *port-greve*: instead of whom, Richard I. ordained two bailiffs; and soon afterwards King John granted them a mayor for their yearly magistracy.

PORTICI, a palace of the king of Naples, fix miles from that capital. It has a charming situation, on the sea-side, near mount Vesuvius. It is enriched with a vast number of fine statues, and other remains of antiquity, taken out of the ruins of Herculaneum.

The museum consists of 16 rooms, in which the different articles are arranged with very great taste. The floors are paved with Mosaic, taken from the recovered towns, and the walls of the court are lined with inscriptions. Besides bulls, statues, medals, intaglios, lamps, and tripods, there is scarcely an article used by the ancients of which a specimen may not be seen in this museum. "But the most valuable room is the library, from the numerous manuscript rolls which it contains.

What a field is here for conjecture! what room for hope! Among this inestimable collection, how many great works are there, of which even the names are now unknown! how many unbroken volumes, whose very fragments, preserved in the writings of the ancient scholiasts, convey to us moral improvement, information, and delight! perhaps all the dramatic pieces of Menander and Philemon; perhaps, nay, certainly, the lost Decades of Livy; for it is impossible to suppose, that among so many rolls, the most admired history of the people who possessed them is not to be found: what private library in Britain is without the best histories of England? But how I tremble for their situation, as Portici is built on the lava that overwhelmed Herculaneum! How I tremble too for the indifference of the king of Naples towards this invaluable treasure, in which all the most enlightened people of Europe are deeply interested! When I first saw them, I had no idea of what they were, as they resemble wooden truncheons burnt almost to charcoal. They are so hard and brittle, that the greatest caution must be used in removing them, lest they crumble to dust; nevertheless, an ingenious friar of Genoa, named *Raggio*, undertook to unroll them; and by a most curious, though tedious process, so far succeeded, as to transcribe three Greek Treatises on Philosophy and Music; but finding (as I hear) no other encouragement than his salary, which was but little more than you pay some of your servants, the work was unhappily discontinued. Were these manuscripts in England, they would not long remain a secret to the world."

PORTICO, in architecture, a kind of gallery on the ground; or a piazza encompassed with arches supported by columns, where people walk under covert. The roof is usually vaulted, sometimes flat. The ancients called it *lacunar*. Though the word *portico* be derived from *porta*, "gate, door;" yet it is applied to any disposition of columns which form a gallery, without any immediate relation to doors or gates. The most celebrated porticoes of antiquity were, those of So-

lomon's temple, which formed the atrium or court, and encompassed the sanctuary; that of Athens, built for the people to divert themselves in, and wherein the philosophers held their disputes and conversations, (see **PORCH**); and that of Pompey at Rome, raised merely for magnificence, consisting of several rows of columns supporting a platform of vast extent; a draught whereof, Serlio gives us in his antique buildings. Among the modern porticoes, the most celebrated is the piazza of St Peter of the Vatican.—That of Covent-Garden, London, the work of Inigo Jones, is also much admired.

PORTII. See **POMPEII**.

PORTLAND, a peninsula in Dorsetshire, of great strength both by nature and art, being surrounded with inaccessible rocks, except at the landing-place, where there is a strong castle, called *Portland castle*, built by king Henry VIII. There is but one church in the island: and that stands so near the sea, that it is often in danger from it. It is now chiefly noted for the freestone which is found there, and which is greatly employed in London, and other parts of England, for building the finest structures. St Paul's church, in particular, was built therewith. W. Long. 2. 35. N. Lat. 50. 30.

The following custom at Portland is worthy of notice. "While I was looking over the quarries at Portland (says Mr Smeaton), and attentively considering the operations, observing how soon the quarrymen would cut half a ton of spawls from an unformed block, and what large pieces flew off at every stroke; how speedily their blows followed one another, and how incessantly they pursued this labour with a tool of from 18 to 20 pound weight; I was naturally led to view and consider the figure of the operative agent; and after having observed, that by far the greatest number of the quarrymen were of a very robust hardy form, in whose hands the tool I have mentioned seemed a mere play-thing, I at last broke out with surprise, and inquired of my guide, Mr Roper, where they could possibly pick up such a set of stout fellows to handle the *kevel*, which in their hands seemed nothing? for I observed, that in the space of 15 minutes, they would knock off as much waste matter from a mass of stone, as any of that occupation I had ever seen before would do in an hour. Says Roper, 'we do not go to fetch those men from a distance, they are all born upon the island, and many of them have never been farther upon the main land than to Weymouth.' I told him, I thought the air of that island must be very propitious, to furnish a breed of men so particularly formed for the business they followed. 'The air (he replied), though very sharp from our elevated situation, is certainly very healthy to working men; yet if you knew how these men are produced, you would wonder the less; for all our marriages here are productive of children.' On desiring an explanation how this happened, he proceeded: 'Our people here, as they are bred to hard labour, are very early in a condition to marry and provide for a family; they intermarry with one another, very rarely going to the main-land to seek a wife; and it has been the custom of the island, from time immemorial, that they never marry till the woman is pregnant.' But pray (said I) does not this subject you to a great number of bastards? Have not your Portlanders the same kind of fickleness

Portii,
Portland.

Watkins's
Travels
through
Switzerland,
Italy, &c.

Portland. in their attachments that Englishmen are subject to? and, in consequence, does not this produce many inconveniences? 'None at all (replies Roper), for previous to my arrival here, there was but one child on record of the parish register that had been born a bastard in the compass of 150 years. The mode of courtship here is, that a young woman never admits of the serious addresses of a young man, but on supposition of a thorough probation. When she becomes with child, she tells her mother, the mother tells her father, her father tells his father, and he tells his son, that it is then proper time to be married.' But suppose, Mr Roper, she does not prove to be with child, what happens then? Do they live together without marriage? or, if they separate, is not this such an imputation upon her, as to prevent her getting another suitor? 'The case is thus managed (answered my friend), if the woman does not prove with child after a competent time of courtship, they conclude they are not destined by Providence for each other; they therefore separate; and as it is an established maxim, which the Portland women observe with great strictness, never to admit a plurality of lovers at one time, their honour is noway tarnished: she just as soon (after the affair is declared to be broke off) gets another suitor, as if she had been left a widow, or that nothing had ever happened, but that she had remained an immaculate virgin.' But pray, Sir, did nothing particular happen upon your men coming down from London? 'Yes (says he) our men were much struck, and mightily pleased with the facility of the Portland ladies, and it was not long before several of the women proved with child; but the men being called upon to marry them, this part of the lesson they were uninstructed in; and on their refusal, the Portland women arose to stone them out of the island; inasmuch, that those few who did not choose to take their sweethearts for *better or for worse*, after so fair a trial, were in reality obliged to decamp; and on this occasion some few bastards were born: but since then matters have gone on according to the ancient custom."

PORTLAND VASE, a celebrated funeral vase which was long in possession of the Baberini family; but which was lately purchased for 1000 guineas by the Duke of Portland, from whom it has derived its present name. Its height is about ten inches, and its diameter where broadest six. There are a variety of figures upon it of most exquisite workmanship, in bas relief of white opaque glass, raised on a ground of deep blue glass, which appears black except when held against the light. It appears to have been the work of many years, and there are antiquarians who date its production several centuries before the Christian era; since, as has been said, sculpture was declining in excellence in the time of Alexander the Great.

Respecting the purpose of this vase, and what the figures on it were meant to represent, there have been a variety of conjectures, which it is not our business to enumerate. We think with Dr Darwin* that it was not made for the ashes of any particular person deceased; and therefore that the subject of its embellishments is not a private history, but of a general nature. But we are not sure that he is right in conjecturing it to represent a part of the Eleusinian mysteries; because that conjecture depends on Warburton's explanation of the 6th book of the *Æneid*, which does not now command

* *Loves of the Plants.*

that respect which it did when it was first proposed. We shall therefore give a short account of the several figures, without noticing any of the theories or conjectures that have been made about them.

In one compartment three exquisite figures are placed on a ruined column, the capital of which is fallen, and lies at their feet among other disjointed stones: they sit under a tree on loose piles of stone. The middle figure is a female in a reclining and dying attitude, with an inverted torch in her left hand, the elbow of which supports her as she sinks, while the right hand is raised and thrown over her drooping head. The figure on her right hand is a man, and that on the left a woman, both supporting themselves on their arms, and apparently thinking intensely. Their backs are to the dying figure, and their faces are turned to her, but without an attempt to assist her. On another compartment of the vase is a figure coming through a portal, and going down with great timidity into a darker region, where he is received by a beautiful female, who stretches forth her hand to help him: between her knees is a large and playful serpent. She sits with her feet towards an aged figure, having one foot sunk into the earth, and the other raised on a column, with his chin resting on his hand. Above the female figure is a Cupid preceding the first figure, and beckoning him to advance. This first figure holds a cloak or garment, which he seems anxious to bring with him, but which adheres to the side of the portal through which he has passed. In this compartment there are two trees, one of which bends over the female figure and the other over the aged one. On the bottom of the vase there is another figure on a larger scale than the one we have already mentioned, but not so well finished nor so elevated. This figure points with its finger to its mouth. The dress appears to be curious and cumbersome, and above there is the foliage of a tree. On the head of the figure there is a Phrygian cap: it is not easy to say whether this figure be male or female. On the handles of the vase are represented two aged heads with the ears of a quadruped, and from the middle of the forehead rises a kind of tree without leaves: these figures are in all probability mere ornaments, and have no connection with the rest of the figures, or the story represented on the vase.

PORTLANDIA, in botany: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is elevated and funnel-shaped; the antheræ are longitudinal; the capsule pentagonal, and retuse at top; bilocular, and crowned with a pentaphyllous calyx.

There are two species, viz. the *grandiflora* and *hexandra*; the former of which has been particularly described by Dr Browne, who has also given a good figure of it. It has frequently flowered in the royal garden at Kew, and in Dr Pitcairn's at Islington.

The external bark is remarkably rough, furrowed, and thick; it has no taste. The inner bark is very thin, and of a dark brown colour. Its taste is bitter and astringent, and its virtues are the same as those of the Jesuit's bark. Infused in spirits or wine with a little orange-peel, it makes an excellent stomachic tincture.

PORT-LOUIS, is a strong town of France, in Bretagne,

Portland
||
Port-Louis.

Port,
Porto.

tagne, in the diocese of Vannes, with a citadel and a good harbour. It was fortified by Louis XIII. from whom it derived its name. It was a station for part of the royal navy and the East India ships belonging to France. It is seated at the mouth of the river Blavet, 27 miles west of Vannes. W. Long. 3. 18. N. Lat. 47. 40.

PORT-Mahon. See MINORCA.

PORTO. See OPORTO.

PORTO-Bello, a town of North America, situated in N. Lat. 9. 3. W. Long. 79. 45. close to the sea, on the declivity of a mountain, which surrounds the whole harbour. This harbour is so large, deep, and safe, that Columbus, who first discovered it, gave it the name of *Porto-Bello*, or the "Fine Harbour," which is now commonly used to denote the town. The number of the houses is about 130; most of them of wood, large and spacious, forming one long street along the strand, with other smaller ones crossing it. The governor of the town is always a gentleman of the army, subordinate to the president of Panama; but having under him the commandants of the forts that defend the harbour. At the east end of the town, on the road to Panama, is a place called *Guinea*, where all the negroes of both sexes, whether slaves or free, have their habitations. This place is very much crowded when the galleons are here, most of the inhabitants of the town quitting their houses entirely for the sake of letting them; while others content themselves with a small part, in order to make money of the rest. The Mulattoes and other poor families also remove either to *Guinea*, or to cottages already erected near it, or built on the occasion. Great numbers of artificers likewise who flock to Porto-Bello from Panama to work at their respective callings during the fair, lodge in *Guinea* for cheapness. Towards the sea, in a large tract between the town and Gloria castle, barracks are erected, in most of which the ships crews keep stalls of sweetmeats, and other kinds of eatables, brought from Spain; but at the conclusion of the fair, when the ships put to sea, all these buildings are taken down, and the town returns to its former tranquillity and emptiness. In 1739, the harbour was defended by a castle and two forts; which were all demolished by admiral Vernon, who, with six ships only, made himself master of this port. The country about Porto-Bello is over-run with mountains and impenetrable forests, except a few valleys, in which are some scattered farms. Among the mountains that surround the harbour is one distinguished by the name of *Capiro*, and by its superior loftiness is a sort of barometer to the country, by foretelling every change of weather. Its top is always covered with clouds, of a density and darkness seldom seen in those of the atmosphere. When these clouds thicken, increase their blackness, and sink below their usual station, it is a sure sign of a tempest; while, on the other hand, their clearness and ascent as certainly indicate the approach of fair weather. These changes are very sudden and frequent here. The summit of the mountain is scarce ever clear from clouds; and when it happens, it is only, as it were, for an instant. Except in the time of the fair, all the inhabitants of Porto-Bello do not amount to 3000; half of whom are Indians, Mulattoes, or Negroes; the Spaniards of any substance

not choosing to reside in a place so extremely unhealthy, and fatal even to the lives of the natives. Ulloa tells us, that the cattle brought hither from Panama or Carthagena, lose their flesh so fast in the best pastures, as to become scarce eatable: he assures us also, that neither horses nor asses are bred here. The heat, indeed, is excessive; and the torrents of rain are so dreadful, sudden, and impetuous, that one not accustomed to them would imagine a second deluge was coming. These torrents are also accompanied with frightful tempests of thunder and lightning, the awfulness of the scene being heightened by the repercussions from the mountains, and the shrieks and howlings of multitudes of monkeys of all kinds which inhabit the surrounding woods.

Fresh water pours down in streams from the mountains, some running without the town, and others crossing it. These waters are very light and digestive; qualities which in other countries would be very valuable, but are here pernicious, producing dysenteries, which the patient seldom survives. However, these rivulets, formed into reservoirs, serve the purposes of bathing, which is here found to be very conducive to health.

As the forests almost border on the houses of the streets, tygers often make incursions into the streets during the night, carrying off fowls, dogs, and other domestic animals, and sometimes even children have fallen a prey to them. Besides the snares usually laid for them, the Negroes and Mulattoes, who fell wood in the forests of the mountains, are very dexterous in encountering them; and some, for a slender reward, even seek them in their retreats.

The town of Porto-Bello, which is thinly inhabited by reason of its noxious air, the scarcity of provisions, and the barrenness of the soil, becomes, after the arrival of the galleons, one of the most populous towns in the world. He who had seen it quite empty, and every place wearing a melancholy aspect, would be filled with astonishment to see the bustling multitudes in the time of the fair, when every house is crowded, the squares and streets encumbered with bales of merchandise and chests of gold and silver, the harbour full of ships and vessels, some loaded with provisions from Carthagena, and others with the goods of Peru, as cocoa, Jesuit's bark, Vicuna wool, and bezoar stones; and this town, at all other times detested for its deleterious qualities, becomes the staple of the riches of the Old and New World, and the scene of one of the most considerable branches of trade in the universe. Formerly the fair was limited to no particular time; but as a long stay in such a sickly place extremely affected the health of the traders, his Catholic majesty transmitted an order that the fair should not last above 40 days; and that, if in that time the merchants could not agree on their rates, those of Spain should be allowed to carry their goods up the country to Peru: and accordingly, the commodore of the galleons has orders to re-embark them, and return to Carthagena; but otherwise, by virtue of a compact between the merchants of both kingdoms, and ratified by the king, no Spanish trader is to send his goods, on his own account, beyond Porto-Bello. The English were formerly allowed to send a ship annually to this fair, which turned

Porto.

Porto,
Portrait.

ed to great account; and, whilst the assiento contract subsisted, either with the English or the French, one of their principal factories was at Porto-Bello.

PORTO-Farina, a port about 12 miles from Cape Carthage, in the bay of Tunis, where formerly the large vessels belonging to the bey were fitted out, and laid up on their return from a cruize. This harbour is safe from the weather, and opens into a large lake, formed by the Mejerdah, which runs through into the sea.—The north-west wind, which blows right upon the shore, together with the soil brought down by the river, which has the same quality as the Nile of overflowing its banks, has formed a bar, so that only small vessels can now enter. It is still the arsenal where the naval stores are kept. E. Long. 10. 16. N. Lat. 37. 12.

PORTO-Farraio, a handsome town of Italy, in the isle of Elba, with a good citadel. It is very strong, and seated on a long, high, steep point of land, to the west of the bay of the same name, which has two forts. It belongs to the great duke of Tuscany, who always keeps a good garrison there. E. Long. 10. 37. N. Lat. 48. 55.

PORTO-Longone, a small but very strong town of Italy, and in the isle of Elba, with a good harbour, and a fortress upon a rock almost inaccessible. The king of Naples has a right to put a garrison therein, though the place belongs to the prince of Piombino. It is seated on the east end of the island, eight miles south-west of Piombino. E. Long. 10. 10. N. Lat. 42. 52.

PORTO-Santo, an island of the Atlantic Ocean, on the coast of Africa, and the least of those called the *Madeiras*. It is about 15 miles in circumference, and produces but little corn; however, there are oxen and wild hogs, and a vast number of rabbits. There are trees which produce the gum or resin called *dragon's blood*; and there is likewise a little honey and wax, which are extremely good. It has no harbour, but good mooring in the road. It belongs to the Portuguese, and is 300 miles west of the coast of Africa. W. Long. 16. 20. N. Lat. 32. 58.

PORTO-Seguro, a government of South America, on the eastern coast of Brasil; bounded on the north by the government of Rio-dos-Hilios, on the east by the North Sea, on the south by the government of Spiritu-Santo, and on the west by the Tupicks. It is a very fertile country, and the capital town is of the same name. It is built on the top of a rock, at the mouth of a river, on the coast of the North Sea, and is inhabited by Portuguese. W. Long. 38. 50. S. Lat. 17. 0.

PORTO-Vecchio, is a sea-port town of Corsica, in the Mediterranean Sea, seated on a bay on the eastern coast of the island. It is 12 miles from Bonifacio, and 40 north of Sardinia. E. Long. 9. 20. N. Lat. 41. 42.

PORTO-Venereo, is a town of Italy, on the coast of Genoa, at the entrance of the gulph of Spetia. It is seated on the side of a hill, at the top of which there is a fort. It has a very good harbour, and is 45 miles south-east of Genoa. E. Long. 9. 38. N. Lat. 44. 5.

PORTRAIT, or **PORTRAITURE**, in painting, the representation of a person, and especially of a face, done from the life. In this sense we use the term *portrait-painting*, in contradistinction to *history-painting*, where a resemblance of persons is usually disregarded. Por-

traits, when as large as the life, are usually painted in oil-colours; sometimes they are painted in miniature with water-colours, crayons, pastils, &c. See **PAINTING**, p. 641.

PORTREE, is a small village, containing a church and a very few houses, with an excellent bay and a good harbour, in the Isle of Sky. "The entrance of the bay (Mr Knox tells us) represents agreeable landscapes on both sides, with excellent pasture."

"The bay of Portree (says Mackenzie), off the houses, is an exceeding good harbour for a few ships of any size; it is well sheltered, the ground good, the depth from five to 14 fathoms, and nothing to fear coming in but a rock, about half a cable's length from Airdrachig Point, on the starboard as you enter the anchorage, part of which is always above water.' It is the only port or harbour to a very considerable division of Sky, on the east side. From this opening to the northern extremity, a course of 20 miles, the shore is one continued line of lofty rocks, where no ship can find refuge in the mildest weather, and where inevitable dangers await the mariners in rough weather."

"James V. of Scotland and several of his nobility landed here, when they made the tour of the Hebrides in 1535; from which circumstance, this fine bay has got the honourable name of *Portree*."

Mr Knox tells us, "that the country round this village, though mountainous, is well inhabited; it raises much grain, and many cattle. Here the late Sir James Macdonald had marked out the lines of a town; and government, it is said, promised to assist him in the work with 500 l.; but the death of that gentleman put an end to these promising appearances, and matters remain in *statu quo*."

PORTSMOUTH, a sea-port town in Hampshire, with one of the most secure and capacious harbours in England, being defended by a numerous artillery, both on the sea and land-side, and very good fortifications. A great part of the royal navy is built here; and here are some of the finest docks, yards, and magazines of naval stores, in Europe. It is seated in the isle of Portsley, being surrounded by the sea except on the north side, where there is a river which runs from one arm of it to the other. It is much resorted to on account of the royal navy, whose usual rendezvous is at Spithead, which is at the east end of the isle of Wight, and opposite to Portsmouth. There is a draw-bridge over the river, and it has always a good garrison. It is governed by a mayor, 12 aldermen, and burgesses, and sends two members to parliament. It has one church, and two chapels, one in the garrison, and one in the Common, for the use of the dock, and others, besides several meeting-houses of the dissenters. The houses of Portsmouth amount to about 2000, and the inhabitants to about 12,000. W. Long. 1. 41. N. Lat. 50. 47.

The town is supposed to receive its name from Port, a famous Saxon chieftain, who, A. D. 501. landed here with his two sons. It made a considerable figure in the time of the Saxons; and from the utility of its situation, was highly favoured by all our monarchs of the Norman line. It was incorporated, and became also a parliamentary borough. In the reign of Edward III. it was in a very flourishing state; but, A. D. 1338, in the very same reign, was burned by the French, when

Portree,
Portsmouth.

Knox's
Tour.

Portsmouth
||
Portugal.

Campbell's
Political
Survey.

when that monarch, which was afterwards ratified by king Richard II. forgave the inhabitants a debt, and remitted their fee-farm for 10 years; within which space they so recovered themselves, as to equip a squadron, which sailed into the mouth of the Seine, sunk two ships, and brought away a great booty. The singular excellence of its port, and the convenience of sitting out fleets from thence in the time of a French war, induced Edward IV. to think of fortifying it, as he actually, in some measure, did; which fortifications were farther carried on by Richard III. But king Henry VII. was the first who settled a garrison therein; which was increased, and the place made still stronger, in the reign of Henry VIII. who had a great dock there, wherein was built the *Henry Grace de Dieu*, which was the largest ship in the navy of his time. The same monarch, remarkably attentive to the security of all maritime places, built what is now called *South-Sea Castle*, for the protection of this.—The improvements made here in the reign of Q. Elizabeth were much superior to all these. King Charles II. after his restoration, directed great alterations, established new docks and yards, raised several forts, and fortified them after the modern manner; which works were augmented under his brother's reign. Notwithstanding this, king William directed likewise fresh alterations and additions; and succeeding princes, following his example, have, at a large expence, extended these fortifications, and taken in a vast deal of ground: so that it is at present, as the importance of the place deserves, the most regular fortress in Britain; and, as it cannot be effectually attacked by sea, may be justly esteemed impregnable.

PORTSMOUTH, the largest town in the state of New Hampshire in North America. It stands on the south-east side of Piscataqua river, about two miles from the sea, and contains about 600 houses, and 4400 inhabitants. The town is handsomely built, and pleasantly situated. Its public buildings are, a court-house, two churches for Congregationalists, one for Episcopalians, and one other house for public worship. Its harbour is one of the finest on the continent, having a sufficient depth of water for vessels of any burthen. It is defended against storms by the adjacent land, in such a manner, as that ships may securely ride there in any season of the year. Besides, the harbour is so well fortified by nature, that very little art will be necessary to render it impregnable. Its vicinity to the sea renders it very convenient for naval trade. A light-house, with a single light, stands at the entrance of the harbour.

PORTSOY, is a handsome sea-port town, situated on a small promontory running into the sea, on the south side of the Murray Frith, in Scotland, about six miles from Cullen, and seven west from Banff. It sends out several fishing vessels, particularly for the Hebride white fishery, and exports a considerable quantity of grain. A manufacture of stocking and sewing thread is also carried on to a considerable amount for the London and Nottingham markets. In the neighbourhood is a stratum of marble, of a dark greenish colour, in which, it is said, the curious substance called ASBESTOS, or earth-flax, has been found. From the asbestos a sort of incombustible cloth is made, which is purified by throwing it into the fire. W. Long. 2. 5. N. Lat. 57. 50.

PORTUGAL, the most westerly kingdom of Eu-

rope, bounded on the west and south by the Atlantic Ocean, and on the east and north by Spain; extending about 310 miles in length, and 150 in breadth.

By modern writers, we find this country constantly styled in Latin *Lusitania*; and it is certain, that anciently a country of Spain went by that name; but it does not by any means appear that the country called by the ancients *Lusitania* had the same boundaries with the modern kingdom of Portugal. Before Augustus Cæsar, *Lusitania* seems to have been bounded on the north by the ocean, and on the south by the river Tagus; by which means it comprehended all Galicia, and excluded two of the six provinces of Portugal. But in the more strict and restrained sense of the word, it was bounded on the north by the Durus, now the Douro, and on the south by the river Anas, now the Guadiana; in which sense it was not quite so long as modern Portugal, but considerably broader.

The commonly received opinion with regard to the etymology of the word *Portugal*, is, that a great number of Gauls landed at Porto, or Oporto, whence it received the name of *Portus Gallorum*, or the *Port of the Gauls*; and in process of time that name gradually extended over the whole country, being softened, or rather shortened, into *Portugal*. But the time when this event happened, the reason why these Gauls came thither, and what became of them afterwards, are all particulars which lie buried in oblivion. It is alleged, however, that, upon an eminence which overlooks the mouth of the river Douro, there stood an ancient town called *Cale*, strong and well peopled, but ill suited for trade; and this occasioned the construction of a lower town or hamlet, which was called *Portus Cale*, that is, the *haven of Cale*; and, in process of time, *Portucalia*. At length, becoming so considerable as to merit an episcopal chair, the bishops subscribed themselves, as the records of ancient councils testify, *Portucalenses*, and the name of the city was transferred to the diocese. It is true, that these bishops afterwards changed their title, and subscribed themselves *Portuenses*, that is, *bishops of Porto*. But the facts just mentioned are actually recorded in authentic histories; and as the diocese of *Portucalia* contained in a great measure that little country in which the sovereignty originally began, the name extended itself, together with the acquisitions of the sovereigns, and has remained to the kingdom, though the diocese itself has changed its name, and possibly on that very account.

Portugal, though even yet but a small kingdom, was originally much smaller. The Spanish and Portuguese historians agree, that Don Alonso, king of Leon and Castile, and son to Don Ferdinand the Great, bestowed his daughter Donna Theresa in marriage upon an illustrious stranger, Don Henry, and gave him with her the frontier province which he had conquered from the Moors, small indeed in extent, but excellently situated, and so pleasant and fertile, that it has sometimes been styled *Medulla Hispanica*, or the *marrow of Spain*. To this territory was added the title of *Count*; but authors are much divided about the time that this stranger came into Spain, and who he was. However, the authors of the Universal History make it pretty evident, that he was a grandson of Robert the first duke of Burgundy. The manner in which

Portugal.
See Map of
Spain and
Portugal.
Boundaries.

Etymology
of the
name.

Originally
only a
small king-
dom.

Portugal. which he obtained the principality above-mentioned is related as follows :

The king, Don Alonso, apprehensive that his success in taking the city of Toledo would bring upon him the whole force of the Moors, sent to demand assistance from Philip I. of France, and the duke of Burgundy, whose daughter he had married. His request was granted by both princes; and a numerous body of troops was speedily collected for his service, at whose head went Raymond count of Burgundy, Henry younger brother of Hugh duke of Burgundy, Raymond count of Tholouse, and many others. They arrived at the court of Don Alonso in the year 1087, where they were received and treated with all possible marks of esteem; and having in the course of two or three years given great proofs of their courage and conduct, the king resolved to bestow his only daughter named *Urraca*, then a mere child, being at most in her ninth year, upon Raymond count of Burgundy, and assigned them the province of Galicia for the support of their dignity. About four years after, Don Alonso being very desirous to express his gratitude to Henry of Burgundy, gave him in marriage a natural daughter of his, born while he remained in exile at Toledo, whose name was *Donna Theresa*; and upon this marriage, he gave up in full property the country which has been already mentioned.

The new sovereign, with his consort, fixed their residence in the town of Guimaraez, pleasantly situated on the banks of the river Ave. The remains of an ancient palace belonging to their successors are still to be seen; and on account of its having been anciently the capital, the king, Don Denis, granted the inhabitants an immunity from taxes, which they still enjoy.

The Portuguese, now finding themselves independent, immediately began, like other nations, to attempt the subjection of their neighbours. Henry is said to have performed great exploits against the Moors; but the accounts of them are so indistinct, that they cannot be taken notice of here. He died in 1112; and was succeeded by his son Don Alonso, then an infant in the third year of his age. In his minority, the kingdom was governed by his mother Donna Theresa, assisted by two able ministers. During the first nine years of their administration, nothing remarkable happened; but after that period, some differences took place between the queen regent (for she had assumed the title of queen after her father's death) and Urraca queen of Castile. Theresa insisted, that some part of Galicia belonged to her in virtue of her father's will; and therefore seized on Tuy, an episcopal town, and a place of some consequence. Urraca, having assembled a numerous army, went in person into Galicia; upon which Theresa was obliged to abandon Tuy, and take shelter in one of her own fortresses. The consequences, in all probability, would have been fatal to the new kingdom, had not the archbishop of Compostella, without whose assistance Urraca could do nothing, demanded leave to retire with his vassals. This offended the queen to such a degree, that she threw him into prison; which act of violence excited such a commotion among her own subjects, that the Portuguese were soon delivered from their apprehensions. Queen Theresa fell immediately after into a similar error, by throwing into prison the arch-

bishop of Braga, who had not espoused her cause so warmly as she had expected. The bishop, however, was quickly delivered by a bull from the pope, who also threatened the kingdom with an interdict; and this was the first remarkable offence which Theresa gave her subjects.

Soon after this, Queen Urraca died, and all differences were amicably settled at an interview between Theresa and Don Alonso Raymond, who succeeded to the kingdom of Castile. But, in 1126, the king of Castile being obliged to march with the whole strength of his dominions against his father-in-law the king of Navarre and Arragon, Theresa took the opportunity of again seizing upon Tuy; but the king soon returning with a superior army, she was again obliged to abandon her conquest. But the greatest misfortune which befel this princess, was a quarrel with her own son Don Alonso Enriquez. It does not appear indeed that Theresa had given him any just cause of offence; but it is certain that a civil war ensued, in which the queen's forces were totally defeated, and she herself made prisoner, in which situation she continued during the remainder of her life.

Enriquez having thus attained to the free and full possession of his dominions, made several attempts upon some places in Galicia, but without success; so that he was at last constrained to make peace with Alonso king of Castile and Leon, who had assumed the title of *Emperor of the Spains*; the more especially as his dominions happened to be at that time invaded by the Moors.—The number of infidels was so great, that the count of Portugal had little hopes of subduing them; but a plague breaking out in the Moorish army, they were obliged to retreat; after which he reduced several places belonging to that nation. But, in the mean time, the emperor Don Alonso, breaking into the Portuguese territories, destroyed every thing with fire and sword. The king of Portugal surprised and cut off a considerable part of his army; which, however, did not hinder the emperor from marching directly towards him.—But, at the intercession of the pope's legate, all differences were accommodated, and a peace concluded; all places and prisoners taken on both sides being delivered up.

In the mean time, the progress of the Christian arms in Spain being reported to Abu-Ali Texefien, the miramolin or chief monarch of the Moors in Barbary, he directed Ismar, or Ishmael, his lieutenant in Spain, to assemble all the forces in the southern provinces, and drive the Christians beyond the Douro. Ishmael immediately began to prepare for putting these orders in execution; and having added a considerable body of troops brought from Barbary to those whom he had raised in Spain, the whole army was very numerous. He was met by Don Alonso of Portugal, in the plains of Ourique, on the banks of the river Tayo; and Ishmael took all possible means to prevent the Christians from passing that river, because his own cavalry, in which the strength of his army chiefly consisted, had thus more room to act. The Portuguese forces were very inconsiderable in number in comparison of the Moors; but Ishmael, being too confident of victory, divided his army into 12 bodies, and disposed them in such a manner as might best prevent the flight, not sustain the attack, of the Christians. The consequence was, that

4
Henry of
Burgundy
the first
count of
Portugal.

5
Differences
with Cas-
tile.

Portugal.

6
Don A-
lonso's wars
with the
Moors and
king of
Castile.

7
Victory of
Ourique.

Portugal.

that his army was overthrown with incredible slaughter, and a vast number of prisoners taken, among whom were 1000 Christians, of the sect styled *Mozarabians*, whom, at the request of Theotonus, prior of the Holy Cross, Don Alonso set at liberty with their wives and children, and procured them settlements in his own dominions.

8
Don Alonso assumes the title of king.

After this signal victory, gained in the year 1139, Don Alonso was proclaimed king by his soldiers, and ever after retained that title, renouncing all kind of subjection to the crown of Spain. Being very desirous, however, of bringing down the power of the emperor, he entered into a league with Raymond count of Barcelona and regent of the kingdom of Arragon against that prince. In consequence of this treaty, he entered Galicia with a considerable force on one side, while Don Raymond did the same on the other. Neither of these enterprises, however, succeeded. The Portuguese monarch met with a severe check in his expedition into Galicia, where he received a dangerous wound, and had some of the nobility who attended him taken prisoners. At the same time he received intelligence that the Moors had invaded his dominions, so that he was obliged to retire; which, however, was not done in sufficient time to prevent the strong fortrefs of Leyria from falling into their hands. This fortrefs they demolished, and put all the garrison to the sword; but the king caused it to be rebuilt stronger than before, and put a more numerous garrison into it; however, he undertook nothing farther this campaign. The war continued with various success till the year 1145, when the king projected an enterprise against Santaren, a strong city about 12 miles from Lisbon. In this he luckily succeeded: and by that means gained a considerable track of country, and a strong barrier to his dominions.

9
Reduces Lisbon and 12 other cities.

After this success Don Alonso caused himself with much ceremony to be chosen and crowned king of Portugal before an assembly of the states, where he also solemnly renounced all dependence on the crown of Spain, declaring, that if any of his successors should condescend to pay tribute or to do homage to that crown, he was unworthy of enjoying the kingdom of Portugal. The next year the king undertook the recovery of Lisbon out of the hands of the Moors; and concerning this expedition there are such numbers of fables, that it is almost impossible to come at the truth. What can be gathered from these accounts is, that he undertook the siege with a small army, and was able to make but little progress in it, partly from the strength of the place, and partly from the numerous garrison by which it was defended. At length, fortunately for Don Alonso, a fleet of adventurers, French, English, Germans, and Flemings, that were going to the Holy Land, anchored at the mouth of the river Tagus, whose assistance he demanded, as not altogether foreign to their design of making war on the infidels. His request was readily granted; and, with their assistance, Lisbon was speedily reduced; which conquest so much raised the reputation of this monarch, and brought such numbers to recruit his army, that before the end of the year 1147 he had reduced 12 other considerable cities.

10
Has his regal dignity confirmed by the pope.

For many years after this, Don Alonso was successful in all his undertakings. He settled the internal government of his kingdom, procured a bull from pope

VOL. XV. Part II.

Alexander III. confirming his regal dignity, undertook many successful expeditions against the Moors, and became master of four of the six provinces which compose the present kingdom of Portugal. In all his undertakings he was assisted by the counsels of his Queen Matilda, who was a woman of great capacity, and sufficient for the government of the kingdom in her husband's absence. By her he had a numerous offspring, particularly three daughters; the eldest of whom, Donna Mafalda or Mathilda, was married to the king of Arragon; the second, Urraca, to Don Ferdinand king of Leon; and the third, Theresa, to Philip earl of Flanders. In 1166, however, the king thought proper, from what provocation we know not, to invade the dominions of his son-in-law Don Ferdinand; and possessed himself of Limmia and Turon, two cities of Galicia, in which he put strong garrisons. The next year, elated with his success, he marched with a numerous army towards Badajos, which he invested; on the news of which, Don Ferdinand, who had assembled a large army at Ciudad Rodrigo, marched to its relief. Yet before he could come within sight of it, it had surrendered to the king of Portugal; upon which Don Ferdinand came to a resolution of besieging his antagonist in his newly conquered city; which Don Alonso perceiving, endeavoured to draw out his forces into the field. Though he was at that time upwards of 70 years of age, he was himself on horseback, and pushing forwards at the head of his horse to get out at the gate, he struck his leg against one of the bolts with such violence that the bone was shattered to pieces. This accident occasioned such confusion, that the Portuguese troops were easily beaten, and Don Alonso was taken prisoner. He was exceedingly mortified by this disgrace, especially as he had no great reason to expect very kind treatment from his son-in-law. However, the king of Leon behaved towards him with the greatest respect and affection. He desired him to lay aside all thoughts of business, and attend to his cure; but finding him restless and impatient, he assured him that he expected nothing more than to have things put into the same condition as before the war, and that they might live in peace and friendship for the future: to which the king of Portugal most readily assented; but returned to his dominions before his cure was perfected, which was the cause of his being lame all the rest of his life. However, this did not abate his military ardour; for, notwithstanding this inconvenience, his courage transported him into the field whenever he was called by the interest of his subjects. Towards the end of his reign, an opportunity seemed to present itself of obtaining once for all an entire release from the disagreeable pretensions of the king of Leon, who, it seems, had insisted on the king of Portugal's doing homage for his kingdom. The opportunity which now presented itself was a quarrel between the king of Leon and his nephew Don Alonso king of Castile. The latter asked assistance from the king of Portugal, which was readily granted. But Don Ferdinand, having received intelligence that the infant Don Sancho (the king's eldest son) was advancing towards Ciudad Rodrigo, assembled his troops on that frontier with such diligence, that he was enabled to attack him unexpectedly, and entirely defeated him. Understanding, however, that Don Sancho was recruiting his forces with great diligence, he

Portugal.

11
His unsuccessful war with Don Ferdinand of Spain.

12
Don Sancho's success against the Moors.

Portugal. he let him know that they might be much better employed against the infidels, who remained careless and unprepared, expecting the issue of the war. Don Sancho made a proper use of this advice; and, after making some motions to amuse the enemy, made a sudden irruption into Andalusia, penetrating as far as Triana, one of the suburbs of Seville. The Moors assembled their forces in order to attack him on his retreat; but Don Sancho having first fatigued them by the celerity of his march, at length chose a strong camp, and, having given his troops time to repose, drew them out and offered the enemy battle. The Moors accepted the challenge, but were entirely defeated; and Don Sancho returned into Portugal with spoils to an immense amount. For some years after the war was continued without any remarkable event; but, in 1184, Joseph king of Morocco, having already transported multitudes of men from Barbary, at length followed in person with a prodigious army, and carried all before him as far as the Tajo. He appeared before the city of Santaren; but having wearied and reduced his army by unsuccessful assaults on that place, he was attacked by the Portuguese forces assisted by Ferdinand of Leon, entirely defeated, and himself killed. By this victory, the Portuguese were left at liberty to improve the interior part of their country, and fortify their frontiers; and during this interval, the king died in the 76th year of his age, in the year 1185.

13
His wife
administra-
tion when
king.

Don Alonso was succeeded by his son Don Sancho I. Of this prince it is remarkable, that, before he ascended the throne, he was of a restless and warlike disposition; but no sooner did he come to the possession of the kingdom, than he became a lover of peace, and began with great assiduity to repair the cities that had suffered most by the war, and to repopulate the country around them. By his steady attention to this, he in a very short time quite altered the appearance of his territories, and procured to himself the glorious title of *The restorer of cities, and father of his country*. In the year 1189, a fleet, composed for the most part of English vessels, but having on board a great number of adventurers of other nations bound to the Holy Land, entered the river of Lisbon. They were very kindly received, and supplied with all kinds of refreshments by Don Sancho, who took this opportunity of soliciting them to assist him in a design he had formed of attacking the city of Silves in Algarve; to which they readily yielded. Having joined a squadron of his own galleys, and marched a body of troops by land, the place was reduced, and the English, according to agreement, rewarded with the plunder. But, in a short time, the Moors from Africa having again invaded Portugal, the town was several times taken and retaken, till at last Don Sancho, being sensible of the difficulties that would attend the keeping of it, caused it to be demolished. His last enterprise was the reduction of Elvas; soon after which he died with the reputation of the best economist that ever sat on the throne of Portugal. With the character of being rather liberal than avaricious, he had amassed a treasure of more than 700,000 crowns in ready money, besides 1400 marks of silver and 100 of gold plate, which he disposed of some time before his death. He was interred by his own command with much less pomp than his father, in the cathedral of Coimbra; and when his body was taken up 400 years

after by order of the king Don Emanuel that it might be laid in a new tomb, it was found uncorrupted.

The history of Portugal affords scarce any event of importance till the year 1289; when, in the reign of Don Denis, a difference commenced with Castile, which subsisted for a long time. Frequent reconciliation took place; but these were either of very short duration, or never sincere. At length, in the reign of John I. Don Juan of Castile, who had also pretensions to the crown of Portugal, invaded that kingdom at the head of the whole force of his dominions, and with the flower of the Castilian nobility entered the province of Alentejo. According to the Portuguese historians, he besieged the city of Elvas without effect; which disappointment enraged him to such a degree, that he determined next year to invade Portugal a second time, and ruin all the country before him. Accordingly, having collected an army of 30,000 men, he invaded Portugal, took and ruined several places, while King John lay inactive, with a small army, waiting for some English succours which he expected. At last he ventured an engagement with the forces which he had; and, notwithstanding the great superiority of the enemy, obtained a complete victory; after which he made an irruption into Castile, and had the good fortune to gain another battle, which fixed him firmly on the throne of Portugal. The Castilians were obliged to consent to a truce of three years, which was soon after improved into a lasting peace.

In 1414, King John undertook an expedition against the Moors in Barbary, where he commanded in person; but before he set out, his queen (Philippa the daughter of John duke of Lancaster) died of grief at the thoughts of his absence. The expedition, however, proved successful, and the city of Ceuta was taken from the Moors almost at the first assault: but scarce had the king left that country, when the princes of Barbary formed a league for the recovery of it; and though they were defeated by the young princes of Portugal, whom John again sent into Barbary, yet the trouble of keeping it was so great, that some of the king's council were of opinion that the town should be demolished. But John, having considered the arguments on both sides, determined to keep the city; and therefore enlarged and strengthened the fortifications, augmenting his forces there to 6000 foot and 2500 horse, which he hoped would be sufficient for keeping off the attacks of the Moors.

King John died in 1428, and was succeeded by his eldest son Edward. He undertook an expedition against Tangier in Barbary: but the event proved very unfortunate; the Portuguese being so shut up by the Moors, that they were obliged to offer Ceuta back again, in order to obtain leave to return to Portugal. The king's son, Don Ferdinand, was left as a hostage for the delivery of Ceuta; but was, with the utmost cruelty and injustice, left in the hands of the infidels, by the king and council of Portugal, who constantly refused to deliver up the place. Many preparations indeed were made for recovering the prince by force; but before any thing could be accomplished the king died in 1430, which put an end to all these designs. See Pedro (Don).

The war with Barbary continued at intervals, but with little success on the part of the Portuguese; and till

Portugal
14
Differences
with Cas-
tile.

15
The Casti-
lians entire-
ly defeated.

16
The city of
Ceuta taken
from the Moors.

17
Passage to
the East In-
dies disco-
vered.

Portugal

till the year 1497, there is no event of any consequence recorded in the history of Portugal. This year was remarkable for the discovery of the passage to the East Indies by the Cape of Good Hope. The enterprising spirit of the Portuguese had prompted them to undertake voyages along the coast of Africa for a considerable time before; but when they undertook their first voyage of discovery, it is probable that they had nothing farther in view than to explore those parts of the coast of Africa which lay nearest to their own country. But a spirit of enterprise, when roused and put in motion, is always progressive; and that of the Portuguese, though slow and timid in its first operations, gradually acquired vigour, and prompted them to advance along the western shore of the African continent, far beyond the utmost boundary of ancient navigation in that direction. Encouraged by success, it became more adventurous, despised dangers which formerly appalled it, and surmounted difficulties which it once deemed insuperable. When the Portuguese found in the torrid zone, which the ancients had pronounced to be uninhabitable, fertile countries, occupied by numerous nations; and perceived that the continent of Africa, instead of extending in breadth towards the west, according to the opinion of Ptolemy, appeared to contract itself, and to bend eastwards, more extensive prospects opened to their view, and inspired them with hopes of reaching India, by continuing to hold the same course which they had so long pursued.

18
Circumstances which facilitated the discovery.

After several unsuccessful attempts to accomplish what they had in view, a small squadron sailed from the Tagus, under the command of Vasco de Gama, an officer of rank, whose abilities and courage fitted him to conduct the most difficult and arduous enterprises. From unacquaintance, however, with the proper season and route of navigation in that vast ocean through which he had to steer his course, his voyage was long and dangerous. At length he doubled that promontory, which, for several years, had been the object of terror and of hope to his countrymen. From that, after a prosperous navigation along the south-east of Africa, he arrived at the city of Melinda, and had the satisfaction of discovering there, as well as at other places where he touched, people of a race very different from the rude inhabitants of the western shore of that continent, which alone the Portuguese had hitherto visited. These he found to be so far advanced in civilization and acquaintance with the various arts of life, that they carried on an active commerce, not only with the nations on their own coast, but with remote countries of Asia. Conducted by their pilots, who held a course with which experience had rendered them well acquainted, he sailed across the Indian ocean, and landed at Calicut, on the coast of Malabar, on the 22d of May 1498, ten months and two days after his departure from the port of Lisbon.

19
The king of the country jealous of his new visitors.

The samin, or monarch of the country, astonished at this unexpected visit of an unknown people, whose aspect, and arms, and manners, bore no resemblance to any of the nations accustomed to frequent his harbours, and who arrived in his dominions by a route hitherto deemed impracticable, received them at first with that fond admiration which is often excited by novelty; but in a short time, from whatever motives, he formed various schemes to cut off Gama and his followers. The

Portuguese admiral, however, was not to be over-reached by such politics as his. From every danger to which he was exposed, either by the open attacks or secret machinations of the Indians, he extricated himself with singular prudence and dexterity, and at last sailed from Calicut with his ships, loaded not only with the commodities peculiar to that coast, but with many rich productions of the eastern parts of India. He returned to Portugal in two years after his sailing from the Tagus, but with a great loss of men; for out of 148 persons whom he took out with him, only 55 returned. The king received him with all possible testimonies of respect and kindness; created him count of Videgueira; and not only declared him admiral of the Indies, but made that office hereditary in his family.

20
The Venetians dread the ruin of their commerce.
On the first intelligence of Gama's successful voyage, the Venetians, with the quick-sighted discernment of merchants, foresaw the immediate consequence of it to be the ruin of that lucrative branch of commerce which had contributed so greatly to enrich and aggrandize their country; and they observed this with more poignant concern, as they were apprehensive that they did not possess any effectual means of preventing, or even retarding, its operation.

21
Account of the settlement of the Portuguese in India.
The hopes and fears of both were well-founded. The Portuguese entered upon the new career opened to them with activity and ardour, and made exertions, both commercial and military, far beyond what could have been expected from a kingdom of such inconsiderable extent. All these were directed by an intelligent monarch, capable of forming plans of the greatest magnitude with calm systematic wisdom, and of prosecuting them with unremitting perseverance. The prudence and vigour of his measures, however, would have availed little without proper instruments to carry them into execution. Happily for Portugal, the discerning eye of Emanuel selected a succession of officers to take the supreme command in India, who, by their enterprising valour, military skill, and political sagacity, accompanied with disinterested integrity, public spirit, and love of their country, have a title to be ranked with the persons most eminent for virtue and abilities in any age or nation. Greater things perhaps were achieved by them than were ever accomplished in so short a time. Within 24 years only after the voyage of Gama, the Portuguese had rendered themselves masters of the city of Malacca, in which the great staple of trade carried on among the inhabitants of all those regions in Asia, which Europeans have distinguished by the general name of the *East Indies*, was then established. This conquest secured to them great influence over the interior commerce of India, while, at the same time, by their settlements at Goa and Diu, they were enabled to engross the trade of the Malabar coast, and to obstruct greatly the long established intercourse of Egypt with India by the Red Sea. In every part of the east they were received with respect; in many they had acquired the absolute command. They carried on trade there without rival or controul; they prescribed to the natives the terms of their mutual intercourse; they often set what price they pleased on the goods which they purchased; and were thus enabled to import from Hindostan and the regions beyond it, whatever is useful, rare, or agreeable, in greater abundance, and of more various kinds, than had been known formerly in Europe.

Portugal

Not satisfied with this ascendant which they had acquired in India, the Portuguese early formed a scheme no less bold than interested, of excluding all other nations from participating of the advantages of commerce with the east; and they accomplished one half of what their ambition had planned.

22
Opposition
made by
the Venetians.

In consequence of this, the Venetians soon began to feel that decrease of their own Indian trade which they had foreseen and dreaded. In order to prevent the farther progress of this evil, they incited the Soldan of the Mameluks to fit out a fleet in the Red Sea, and to attack those unexpected invaders of a gainful monopoly, of which he and his predecessors had long enjoyed undisturbed possession. The Portuguese, however, encountered his formidable squadron with undaunted courage, entirely defeated it, and remained masters of the Indian ocean. They continued their progress in the east almost without obstruction, until they established there a commercial empire; to which, whether we consider its extent, its opulence, the slender power by which it was formed, or the splendor with which the government of it was conducted, there had hitherto been nothing comparable in the history of nations. Emanuel, who laid the foundation of this stupendous fabric, had the satisfaction to see it almost completed. Every part of Europe was supplied by the Portuguese with the productions of the east; and if we except some inconsiderable quantity of them, which the Venetians still continued to receive by the ancient channels of conveyance, our quarter of the globe had no longer any commercial intercourse with India, and the regions of Asia beyond it, but by the Cape of Good Hope.

23
Inquisition
introduced
into Portugal.

In September 1522, King Emanuel died of an epidemical fever, and was succeeded by his son John III. The most remarkable transaction of this prince's reign was the introduction of the inquisition into his dominions. This happened in the year 1525, or, as some say, in 1535. A famine happening to cease in a short time after it was introduced, the priests persuaded the ignorant multitude that it was a blessing from heaven on account of the erecting such an holy tribunal. However, it was not long before the bulk of the nation perceived what kind of a blessing the inquisition was: but their discernment came too late; for by that time the inquisitors had acquired such power, that it became equally dangerous and ineffectual to attempt disclosing any of their mysteries.

In the mean time Solymán the Magnificent, the most enlightened monarch of the Ottoman race, observing the power and the opulence of the Portuguese rising, and attributing it to its proper cause, and eager to supplant them, sent orders to the bashaw of Egypt to employ his whole strength against the Christians in the East Indies. The bashaw, in obedience to these orders, sailed out from the Red Sea with a greater naval force than ever the Mohammedans had employed before; having 4000 Janizaries, and 16,000 other land troops on board. Yet, by the courage and conduct of the Portuguese officers and soldiers, all this mighty armament was defeated, and their East India possessions saved from the danger which threatened them. In Africa likewise the king of Fez was baffled before the town of Safi, and fresh quarrels breaking out among the princes gave great relief to the Christians, who had long been obliged to carry on a defensive war,

and had more than once been on the very brink of ruin. For a long time indeed their safety had been derived only from the quarrels of the Moors among themselves; for such was the envy and jealousy which reigned among the Portuguese, that they could never unite heartily in opposing the common enemy; and therefore, had their enemies united against them, they must certainly have been cut off. But whenever the chiefs quarrelled with each other, one party was sure to have recourse to the Portuguese; who, by sending them a small supply, secured quiet to themselves, and had the pleasure of seeing their enemies destroy one another. Yet in the end even this had bad consequences; for, on one hand, it kept up a martial spirit among the Moors, and on the other it made them acquainted with the Portuguese discipline; so that after every short interval of repose they not only found them as much enemies as before, but much more formidable than ever. The consequence of all this was, that King John began to apprehend that the conquest of Barbary was impossible, and therefore to limit his desires to the keeping of those few fortresses which he had already; which, though a necessary and prudent measure, displeased the generality of his subjects.

24
Bad state of
affairs in
Barbary.

King John exerted himself much in the settlement of Brazil in South America, which he brought into a very good state, caused several strong towns to be erected there, and took all possible methods to encourage the conversion of the natives to Christianity. He also made many regulations for the welfare and happiness of his subjects. The disputes of the nobility about precedence were frequently attended with very disagreeable consequences, which made the king resolve once for all to settle them by established rules; and the rules established by him on this occasion have subsisted ever since, and in a great measure prevent these altercations. He had other great designs in his mind, particularly with regard to the reformation, which he had pushed very far with respect to religious persons of both sexes; but, on a close examination of his affairs, he found his subjects in general to have been so much injured by his leaving their concerns to the inspection of his council, that he was thrown by the grief of it into a kind of apoplexy, from which he never recovered. His death happened in June 1557; and he was succeeded by his son Don Sebastian III. an infant of three years of age.

After the death of King John, the administration remained in the hands of the queen, grandmother to Sebastian, who behaved with great prudence and circumspection. The Moors, however, supposing that under a minority they might be able to dispossess the Christians of such places as they held in Barbary, laid close siege to Mafagan. But the queen-regent sent such speedy succours, and promised such rewards to those who distinguished themselves, that the Moors, though they brought 80,000 men into the field, were obliged to abandon the enterprise. This was at first magnified as a high instance of the queen's capacity and wisdom; but in a short time the natural aversion which the Portuguese had to the government of women, together with the prejudice they had against her country, as being a Castilian, appeared so plainly, and gave her so much uneasiness, that of her own accord she resigned her authority into the hands of cardinal Don Henry the

Portugal.
25
Prepos-
tious educa-
tion of the
young king
Sebastian.

the king's brother. By him Don Alexius de Meneses was appointed the king's governor, and Gonfales de Gomera with two other priests his preceptors. By means of those instructors the king's education was totally marred. His governor assiduously inculcated upon him that the chief virtue of a king was courage; that danger was never to be avoided, but always surmounted, let the occasion be what it would. His other tutors, instead of instructing him in the true religion, only inspired him with an abhorrence of professed infidels: the consequence of all which was, that he became rash, inconsiderate, and obstinate; all which qualities conspired to draw upon him the catastrophe which ruined both him and the kingdom.

After the king was grown up to man's estate, his desire was to distinguish himself against the infidels. He himself chose an expedition to the East Indies; but the prime minister Alcoçova, who did not choose to

26
ex-
pedition a-
gainst A-
frica.

nd his monarch to such a distance, substituted Africa in its stead. This expedition the king entered into in the most inconsiderate and absurd manner. He first sent over Don Antonio prior of Crato, with some hundreds of soldiers; carried his principal courtiers over with him from a hunting match, and without equipages; he then sent for the duke of Aveiro, with such troops as he could collect on the short warning he had got; and when all these were assembled, the king spent his time in hunting, and slight excursions against the enemy, without doing any thing of consequence, except exposing his person upon all occasions. At length he returned to Portugal in such tempestuous weather, that his subjects had given him up for lost; when they were agreeably surprised by his unexpected arrival in the river of Lisbon, which they celebrated with the greatest rejoicings.

The little successes which attended the king in this expedition served only to inflame him more with desire for another; so that from the time he returned, he seemed to think on nothing else. He was highly delighted also with an accident which at this time furnished him with a pretence for war, though of that he stood in no great need. Muley Hamet, king of Fez and Morocco, had been dispossessed of his dominions by his uncle Muley Moloch. At the beginning of this war Don Sebastian had offered him his troops in Africa, which offer was rejected with contempt: but now being a fugitive, and having in vain applied for assistance to Philip of Spain, Muley Hamet applied to the king of Portugal; and, that he might the more easily succeed, caused the fortress of Arzila, which his father had recovered, to be restored to the Portuguese. The king was in rapture at this event, and fancied that his glory would exceed that of all his predecessors. He was advised against this expedition, however, by all his friends. King Philip of Spain having done every thing to dissuade him from it in a personal conference, sent Francisco Aldana, an old and experienced officer, to Morocco; and at his return ordered him to attend Don Sebastian, in order to give him an account of the state of affairs in that country. This he performed with the greatest fidelity, but without any effect. The queen dowager and cardinal united in their endeavours to divert him from this unfortunate enterprise; but he treated them both with so little respect, that his grandmother broke her heart; and the cardinal, to show his dis-

taste to the measure, retired to Evora without coming either to court or council; which example was followed by many of the nobles. Many of these, however, sent very free remonstrances to the king on the impropriety of his conduct; and King Philip sent to him the duke de Medina Celi, once more to lay before him the reasons why he thought his scheme impracticable, and to put him in mind that he had no hand in pushing him upon his destruction, or of concealing from him the dangers into which he seemed determined to plunge himself and his subjects. Lastly, he received a letter on the subject from Muley Moloch himself, wherein that prince explained to him his own right to the crown of Fez, and showed that he had only dispossessed a tyrant and a murderer, who had therefore no right to his friendship or assistance. He next assured him that he had no reason to fear either the power or neighbourhood of the Portuguese; as a proof of which, and as a mark of his esteem, he was content to make him a present of ten miles of arable ground round each of the fortresses he possessed in Africa, and which indeed were no more than four, viz. Tangier, Centa, Masagan, and Arzila. At the same time he addressed himself to King Philip of Spain, with whom he was on good terms, desiring him to interpose with his nephew Sebastian, that things might be yet adjusted without the effusion of human blood. But the king of Portugal was deaf to all salutary advice; and therefore paid no regard to this letter, nor to the remonstrances of his uncle. On the 24th of June 1577, therefore, he set sail from the bar of Lisbon with a fleet of 50 ships and five galleys, twelve pieces of cannon, and transports and tenders, making up near 1000 sail. His troops consisted of 9000 Portuguese foot; 3000 Germans; 700 Italians commanded by Sir Thomas Stukeley, an English exile, but remarkably brave; 2000 Castilians and 300 volunteers, commanded by Don Christopher de Tuvara master of the horse, a man of courage, but without either conduct or experience. He touched first at Lagos bay in the kingdom of Algarve, where he remained for four days: thence he proceeded to Cadiz; where he was magnificently feasted for a week by the duke de Medina Sidonia, who took the opportunity once more, by order of Philip, of dissuading him from proceeding further in person. But this exhortation proved as fruitless as the rest; and the king having failed with a strong detachment for Tangier, ordered Don Diego de Souza, his commander in chief, to follow with the remaining part of the army.

The troops landed on the coast of Africa without any bad accident, and joined at Arzila. Here the king was met by the cheriff Muley Hamet, on whose account he had undertaken the war, who delivered him his son Muley, a boy of 12 years of age, as a hostage, and brought a reinforcement of 300 Moors. The boy was sent to Masagan under a strong guard; but the father remained in the Portuguese camp. Here it was resolved in a council of war to reduce the town of Larache, but it was disputed whether the troops should proceed thither by land or sea. Don Sebastian, who espoused the former opinion, finding himself opposed by Muley Hamet, gave him such a rude answer, that he left his presence in discontent; after which the king's opinion prevailed, and the army began its march on the 29th of July. As they proceeded, the king received a

Portugal.

27
Account of
his forces.

Portugal

28
Move-
ments and
disposition
of the ar-
mies.

letter from the duke of Alba, requesting him to attempt nothing beyond the taking of the town of Larache. Along with the letter was sent an helmet which had been worn by Charles V.

On the other hand Muley Moloch, having intelligence of this formidable invasion, took the field, though at that time so ill of a fever that he could not sit on horseback, with 40,000 foot and 60,000 horse. He conducted every thing, notwithstanding his distressed situation, with the greatest prudence. Finding some reason to suspect that part of his army were desirous of going over to his rival, he proclaimed that such as inclined to join their old master were at liberty to do it. This at once put a stop to the defection, and only a very few made use of the liberty which was granted them. Standing in doubt likewise of the fidelity of a body of 3000 horse, he sent them to reconnoitre the enemy, by which act of confidence he secured them. Still, however, he feared that his officers might be corrupted by the Portuguese gold; for which reason he changed the disposition of his army entirely, so that none of his officers commanded the corps to which they had been accustomed; and therefore, having new men to deal with, had none whom they could trust.

Having taken these precautions, he advanced against the Portuguese army with such celerity, that he came in sight of them on the 3d of August. On this Don Sebastian called a council of war; in which many who out of complaisance had given their opinions for this march, were now for returning. They were separated from the enemy by a river, and the Moors were masters of the ford, so that it was impossible to force them immediately in their posts; neither was it practicable for them to wait for a more favourable opportunity, because they had no provisions. The foreign officers, on the contrary, were of opinion that fighting was now become necessary, and a retreat dangerous. This, however, was violently opposed by the cheriff, who saw plainly that they ran a great risk of being defeated and of losing all, while at the same time they were not certain of gaining any thing of consequence though they should be victorious: whereas, if they drew down towards the sea, they might entrench themselves till they were relieved by their fleet; during which interval if Muley Moloch should die, he looked upon it as certain that a great part of the army would desert to him, which would render him master not only of the kingdom, but of the fate of the Christians also. When he found that the king was bent on fighting, he only requested that the engagement might be delayed till 4 o'clock in the afternoon, that, in case of a defeat, they might have some chance of escaping: but even in this he could not prevail; for the king having disposed of every thing for a battle the next day, was impatient to begin the onset as soon as it was light.

In the mean time Muley Moloch was so sensible of the advantages of his situation, that he was inclined to take the whole Portuguese army prisoners; but finding his disease increase, so that he had no hopes of recovery, he came to the resolution to fight, that his antagonist might not avail himself of his death. The disposition of the Christian army was very regular and correct, through the care of some old officers in Don Sebastian's service: the infantry were disposed in three lines; the battalion of volunteers made the vanguard;

the Germans commanded by colonel Amberg, and the Portuguese,

Italians by Sir Thomas Stuckeley, were on the right; the Castilian battalions on the left; the Portuguese in the centre and rear; the cavalry, consisting of about 1500 men, partly on the right under the command of the duke d'Avegro, to whom the cheriff joined himself with his horse: on the left was the royal standard, with the rest of the cavalry, under the command of the duke of Barcelos eldest son to the duke of Braganza, Don Antonio prior of Crato, and several other persons of great rank. The king took post at first with the volunteers. Muley Moloch disposed also his troops in three lines: the first consisted of the Andalusian Moors, commanded by three officers who had distinguished themselves in the wars of Granada; the second of renegadoes; and the third of the natives of Africa. They moved in a half moon, with 10,000 horse on each wing, and the rest in the rear, with orders to extend themselves in such a manner as to encompass the Christian army. Muley Moloch, though extremely weak, was taken out of his litter, and set on horseback, that he might see how his commands had been obeyed; and being perfectly satisfied with the situation of his troops, he directed the signal of battle to be given. The Christians advanced with the greatest

29
The Portu-
guese army
entirely de-
feated.

resolution; broke the first line of the Moorish infantry, and disordered the second. On this Muley Moloch drew his sword, and would have advanced to encourage his troops, but that his guards prevented him; on which his emotion of mind was so great, that he fell from his horse. One of his guards caught him in his arms, and conveyed him to his litter; where he immediately expired, having only time to lay his finger on his lips by way of enjoining them to conceal his death. But by this time the Moorish cavalry had wheeled quite round, and attacked the Christian army in the rear: upon which the cavalry in the left wing made such a vigorous effort that they broke the Portuguese on the right; and at this time the cheriff, in passing a rivulet, was drowned. In this emergency, the Germans, Italians, and Castilians, did wonders; but the Portuguese, according to their own historians, behaved indifferently. Attacked on all sides, however, they were unable to resist; and the whole army, except about 50 men, were killed or taken prisoners. The fate of the king is variously related. According to some, he had two horses killed under him, and then mounted a third. His bravest officers were killed in his defence; after which the Moors surrounding him, seized his person, stripped him of his sword and arms, and secured him. They immediately began to quarrel about whose prisoner he was; upon which one of the generals rode in among them, crying, "What, you dogs, when God has given you so glorious a victory, would you cut one another's throats about a prisoner?" at the same time discharging a blow at Sebastian, he brought him to the ground, when the rest of the Moors soon dispatched him. Others affirm, that one Lewis de Brito meeting the king with his standard wrapped round him, Sebastian cried out, "Hold it fast, let us die upon it!" upon which charging the Moors, he was seized, rescued by Brito, who was himself taken with the standard, and carried to Fez. He affirmed, that after he was taken, he saw the king at a distance, and unpursued. Don Lewis de Lima met him afterwards

Portugal. making towards the river; and this is the last account we have of his being seen alive.

Muley Hamet, the brother of Muley Moloch, was proclaimed king by the Moors immediately after the battle. Next day, having ordered all the prisoners to be brought before him, the new sovereign gave orders to search for the body of Don Sebastian. The king's valet-de-chambre brought back a body, which he said was that of his master, but so disfigured with wounds, that it could not well be known; so that notwithstanding the most diligent search, this monarch's death could never be properly authenticated. This body, however, was preserved by Muley Hamet, who delivered it up as the body of Don Sebastian to King Philip of Spain. By him it was sent to Centa, from whence it was transported to Portugal, and buried among his ancestors in the monastery at Belem, with all possible solemnity.

By this terrible disaster, the kingdom of Portugal, from being the most eminent, sunk at once into the lowest rank of the European states. All the young nobility were cut off, or carried into slavery: the kingdom was exhausted of men, money, and reputation; so that Don Henry, who assumed the government after the death of his brother Don Sebastian, found himself in a very disagreeable situation. The transactions of his reign were quite trifling and unimportant; but after his death a great revolution took place. The crown of Portugal was claimed by three different competitors; viz. the prince of Parma, the dutchess of Braganza, and Philip of Spain. Whatever might have been the merits of their respective claims, the power of Philip quickly decided the contest in his favour. He found his schemes facilitated by the treachery of the regents, who took the most scandalous methods of putting the kingdom into his hands. Under pretence of inspecting the magazines, they took out some of the powder, and mixed the rest with sand: they appointed an agent to go to France for succours, from whence they knew that they could not arrive in time; they dissolved the states as soon as they discovered that they were bent on maintaining the freedom of the nation; and, under a show of confidence, sent off to distant places such of the nobility as they suspected.

King Philip, finding every thing in his favour, commanded the duke of Alva to invade Portugal, at the head of 20,000 men. The people, perceiving that they were betrayed, exclaimed against the governors, and placed on the throne Don Antonio prior of Crato. But his forces being inexperienced, and he himself behaving in a very improper manner, he was quickly defeated by the duke of Alva, and forced to fly out of the kingdom, which he effected with great difficulty. On his flight the whole kingdom submitted, together with the garrisons in Barbary, the settlements on the western coast of Africa, of Brazil, and in the East Indies. All the Madeiras, however, except the isle of St Michael, held out for Don Antonio until they were reduced, and the French navy, who came to their assistance, entirely defeated and destroyed.

Philip made his entry into Lisbon as soon as the kingdom was totally reduced, and endeavoured to conciliate the affections of the people by confirming the terms which he had before offered to the states. These terms were, that he would take a solemn oath to main-

tain the privileges and liberties of the people: that the states should be assembled within the realm, and nothing proposed in any other states that related to Portugal: that the viceroy or chief governor should be a native, unless the king should give that charge to one of the royal family: that the household should be kept on the same footing: that the post of first president, and of all offices, civil, military, and judicial, should be filled with Portuguese; all dignities in the church and in the orders of knighthood confined to the same; the commerce of Ethiopia, Africa, and the Indies, reserved also to them, and to be carried on only by their merchants and vessels: that he would remit all imposts on ecclesiastical revenues: that he would make no grant of any city, town, or jurisdiction royal, to any but Portuguese: that estates resulting from forfeitures should not be united to the domain, but go to the relations of the last possessor, or be given to other Portuguese for recompense of services: that when the king came to Portugal, where he should reside as much as possible, he should not take the houses of private persons for his officers lodging, but keep to the custom of Portugal: that wherever his majesty resided, he should have an ecclesiastic, a treasurer, a chancellor, two masters of requests, with under officers, all of them Portuguese, who should dispatch every thing relating to the kingdom: that Portugal should ever continue a distinct kingdom, and its revenue be consumed within itself: that all matters of justice should be decided within the realm: that the Portuguese should be admitted to charges in the households of the king and queen of Spain: that all duties on the frontiers should be taken away: and, lastly, that Philip should give 300,000 ducats to redeem prisoners, repair cities, and relieve the miseries which the plague and other calamities had brought upon the people. All these conditions, formerly offered and rejected by the Portuguese, the king now confirmed: but whereas the duke of Ossuna, by way of security for these conditions, had promised them a law, that if the king did not adhere to them, the states should be freed from their obedience, and might defend their right by the sword, without incurring the reproach of perjury, or the guilt of treason; this he absolutely refused to ratify.

All these concessions, however, did not answer the purpose; nay, though Philip was to the last degree lavish of honours and employments, the Portuguese were still dissatisfied. This had also an effect which was not foreseen: it weakened the power, and absorbed the revenues, of the crown; and, by putting it out of the power of any of his successors to be liberal in the same proportion, it raised only a short-lived gratitude in a few, and left a number of malecontents, to which time was continually adding.

Thus Philip, with all his policy, and endeavours to please, found his new subjects still more and more disgusted with his government, especially when they found their king treating with the utmost severity all those who had supported Don Antonio. The exiled prince, however, still styled himself *king of Portugal*. At first he retired to France, and there demanded succours for the recovery of his dominions. Here he found so much countenance, that with a fleet of near 60 sail, and a good body of troops on board, he made an attempt upon the Terceras, where his fleet was beat by the Spaniards; and a great number of prisoners being taken,

30
Portugal
conquered
by Philip
of Spain.

31
Terms
granted by
him to his
new sub-
jects.

Portugal.

32
Cannot
conciliate
their affec-
tions.

33
is disturbed
by Don
Antonio.

don,

Portugal. ken, all the officers and gentlemen were beheaded, and a great number of meaner people hanged. Don Antonio, notwithstanding, kept possession of some places, coined money, and performed many other acts of regal power; but was at length constrained to retire, and it was with some difficulty that he did so, and returned into France. He passed from thence into England, where he was well received; and many fitted out privateers to cruise against the Spaniards under his commission. But after king Philip had ruined the naval power of Portugal as well as Spain, by equipping the armada, Queen Elisabeth made no difficulty of owning and assisting Don Antonio, and even of sending Sir John Norris and Sir Francis Drake with a strong fleet and a great army to restore him. Upon this occasion Don Antonio sent his son Don Christopher a hostage to Muley Hamet king of Fez and Morocco, who was to lend him 200,000 ducats. But king Philip prevented this by surrendering Arzila: and this disappointment, the unseasonable enterprise upon Corunna, and the disputes that arose between Norris and Drake, rendered that expedition abortive; so that, except carrying the plague into England, it was attended with no consequences worthy of notice. He remained some time after in England: but finding himself little regarded, he withdrew once more into France, where he fell into great poverty and distress; and at length dying in the 64th year of his age, his body was buried in the church of the nuns of Ave Maria, with an inscription on his tomb, in which he is styled *king*. He left several children behind him, who, on account of his being a knight of Malta, and having made a vow of virginity at his entrance into the order, were looked upon as illegitimate. He preserved, even to the day of his death, a great interest in Portugal; and had drawn from thence, in the course of his life, immense sums of money; which had been squandered in many fruitless negotiations and attempts to disturb the possessions of king Philip in almost all parts of his dominions, and particularly in the Indies, where the Portuguese were rather more averse to the Castilian yoke, or at least testified their aversion more openly, than in Europe.

34.
Impostors
pretending
to be Don
Sebastian.

But Don Antonio was not the only pretender to the crown of Portugal: for the people, partly through the love of their prince, and partly from their hatred to the Castilians, were continually feeding themselves with the hopes that Don Sebastian would appear and deliver them; and in this respect such a spirit of credulity reigned, that it was said proverbially, they would have taken a negro for Don Sebastian. This humour put the son of a tiler at Alcobaza, who had led a profligate life, and at length turned hermit, to give himself out for that prince; and having with him two companions, one of them styled himself *Don Christopher de Tavora*, and the other the *bishop of Guarda*, they began to collect money, and were in a fair way of creating much disturbance, if the cardinal arch-duke had not caused him to be apprehended; and after leading him ignominiously through the streets of Lisbon, he who took the name of *Sebastian* was sent to the galleys for life, and the pretended bishop was hanged. Not long after, Gonfalo Alvarez, the son of a mason, gave himself out for the same king; and having promised marriage to the daughter of Pedro Alonso, a rich yeoman, whom he created earl of Torres Novas, he assembled a

body of about 800 men, and some blood was spilt before he was apprehended: at length, being clearly proved to be an impostor, himself and his intended father-in-law were publicly hanged and quartered at Lisbon; which, instead of extinguishing this humour, farther increased it.

There was, however, a person who appeared, about 20 years after the fatal defeat of Sebastian, at Venice, who created much more trouble. He assumed the name of *Don Sebastian*, and gave a very distinct account of the manner in which he had passed his time from that defeat. He affirmed, that he had preserved his life and liberty by hiding himself amongst the slain: that, after wandering in disguise for some time in Africa, he returned with two of his friends into the kingdom of Algarve: that he gave notice of this to the king Don Henry: that finding his life sought, and being unwilling to disturb the peace of the kingdom, he returned again among the Moors, and passed freely from one place to another in Barbary, in the habit of a penitent: that after this he became a hermit in Sicily; but at length resolved to go to Rome, and discover himself to the pope. On the road he was robbed by his domestics, and came almost naked to Venice, where he was known, and acknowledged by some Portuguese. Complaint being made to the senate, he was obliged to retire to Padua. But the governor of that city ordering him also to depart, he, not knowing what to do, returned again to Venice; where, at the request of the Spanish ambassador, who charged him not only with being an impostor, but also with many black and atrocious crimes, he was seized, and thrown into prison. He underwent 28 examinations before a committee of noble and impartial persons; in which he not only acquitted himself clearly of all the crimes that had been laid to his charge, but entered also into so minute a detail of the transactions that had passed between himself and the republic, that the commissioners were perfectly astonished, and showed no disposition to declare him an impostor; moved more especially by the firmness of his behaviour, his singular modesty, the sobriety of his life, his exemplary piety, and his admirable patience under his afflictions. The noise of this was diffused throughout Europe, and the enemies of Spain endeavoured everywhere to give it credit.

The state, however, refused to discuss the great point, whether he was or was not an impostor, unless they were requested so to do by some prince or state in alliance with them. Upon this the prince of Orange sent Don Christopher, the son of the late Don Antonio, to make that demand; and at his request an examination was made with great solemnity: but no decision followed; only the senate set him at liberty, and ordered him to depart their dominions in three days. He went therefore, by the advice of his friends, to Padua, but in the disguise of a monk, and from thence to Florence; where he was arrested by the command of the grand duke, who delivered him to the viceroy of Naples. The count de Lemos, then in possession of that dignity, died soon after, before whom he was first brought; this man asserted, he must know him to be Don Sebastian, since he had been twice sent to him from the king of Spain. He remained prisoner several years in the castle Del Ovo, where he endured incredible hardships. At length he was brought out, led with infamy through the streets

35
Account of
a remarkable
one.

Portugal of the city, and declared to be an impostor, who assumed the name of *Sebastian*: at which words, when proclaimed before him, he said gravely, *And so I am*. In the same proclamation it was affirmed, that he was in truth a Calabrian; which as soon as he heard, he said, *It is false*. He was next shipped on board a galley as a slave; then carried to St Lucar, where he was some time confined; from thence he was transferred to a castle in the heart of Castile, and never heard of more. Some persons were executed at Lisbon for their endeavours to raise an insurrection on his behalf: but it was thought strange policy, or rather a strange want of policy, in the Spaniards, to make this affair so public without proofs; and the attempt to silence this objection, by affirming him to be a magician, was justly looked upon as ridiculous.

36
Bad consequences of the Spanish administration.

The administration of affairs in Portugal, during the reign of Philip, was certainly detrimental to the nation; and yet it does not appear that this flowed so much from any ill intention in that monarch, as from errors in judgment. His prodigious preparations for the invasion of England impoverished all his European dominions; but it absolutely exhausted Portugal. The pretensions of Don Antonio, and the hopes of despoiling their Indian fleets, exposed the Portuguese to the resentment of the English; from which the king having granted away all his domains, wanted power to defend them. Their clamours were not at all the less loud for their being in some measure without cause. The king, to pacify them, borrowed money from the nobility upon the customs, which were the only sure remedy he had still left; and this was attended with fatal consequences. The branches, thus mortgaged, became, and continue to this hour, fixed and hereditary; so that the merchant was oppressed, and the king received nothing. This expedient failing, a tax of three *per cent.* was imposed, in the nature of ship-money, for the defence of the coasts and the commerce, which for some years was properly applied; but it then became a part of the ordinary revenue, and went into the king's exchequer without account. This made way for diverting other appropriated branches; as for instance, that for the repair of fortifications, the money being strictly levied, and the works suffered to decay and tumble down; and for the maintenance of the conquests in Africa, by which the garrisons mouldered away, and the places were lost. Upon the whole, in the space of 18 years, the nation was visibly impoverished: and yet the government of Philip was incomparably better than that of his successors; so that his death was justly regretted; and the Portuguese were taught by experience to confess, that of bad masters he was the best.

His son Philip, the second of Portugal and the third of Spain, sat 20 years upon the throne before he made a visit to Portugal, where the people put themselves to a most enormous expence to receive him; for which they received little more than the compliment, that before his entry into Lisbon, he knew not how great a king he was. He held an assembly of the states, in which his son was sworn successor. Having done all that he wanted for himself, he acquired a false idea of the riches of the nation from an immoderate and foolish display of them during his short stay at Lisbon; and having shown himself little, and done less, he returned into Spain; where he acted the part of a good king

Vol. XV. Part II.

upon his death-bed, in deploring bitterly that he never thought of acting it before. The reign of Philip III. and IV. was a series of worse measures, and worse fortune: all his dominions suffered greatly; Portugal most of all. The loss of Ormus in the East, of Brazil in the West Indies, together with the shipwreck of a fleet sent to escort that from Goa, brought the nation incredibly low, and encouraged the conde duke to hope they might be entirely crushed. These are the heads only of the transactions for 40 years: to enter in any degree into the particulars, is, in other words, to point out the breaches made by the Spanish ministers on the conditions granted by king Philip; which, with respect to them, was the original contract, and unalterable constitution of Portugal while subject to the monarchs of Castile; and which, notwithstanding, they so often and so flagrantly violated, that one would have imagined they had studied to provoke the wrath of heaven, and insult the patience of men, instead of availing themselves, as they might have done, of the riches, power, and martial spirit of the Portuguese people.

It was the very basis and foundation of their privileges, that the kingdom should remain separate and independent, and consequently that Lisbon should continue as much its capital as ever, the several supreme councils and courts residing; so that the natives of this realm might not be obliged to travel in search of justice. So little, or at least so short a time, was this observed, that neither promotion nor justice was to be obtained without journeys, and Madrid was not more the capital of Castile than of Portugal. The general assembly of estates was to be held frequently, and they were held thrice in the space of 60 years; and of these twice within the first three. The king was to reside in this realm, as often and as long as possible; in compliance with which, Philip I. was there but once, Philip II. but four months, and Philip III. was never there at all. The household establishment was suppressed through all their reigns. The viceroy was to be a native of Portugal, or a prince or princess of the blood; yet when any of the royal family bore the title, the power was in reality in the hands of a Spaniard. Thus, when the princess of Mantua was vice-queen, the marquis de la Puebla was to assist in council, and in all dispatches; and she was to do nothing without his advice. The council of Portugal, which was to be composed entirely of natives, was filled with Castilians, as the garrisons also were, though the contrary had been promised. The presidents of provinces, or corregidores, were to be natives; but by keeping those offices in his own hands, the king eluded this article. No city, town, or district, were to be given but to Portuguese; yet the duke of Lerma had Beja, Serpa, and other parts of the demesnes of the crown, which were formerly appendages of the princes of the blood. None but natives were capable of offices of justice, in the revenue, in the fleet, or of any post civil or military; yet these were given promiscuously to foreigners, or sold to the highest bidder; not excepting the governments of castles, cities, and provinces. The natives were so far from having an equal chance in such cases, that no posts in the presidials were ever given to them, and scarce any in garrisons; and whenever it happened, in the case of a person of extraordinary merit, whose pretensions could not be rejected, he was either removed, or not allowed to exercise his charge;

Portugal.
37
Great losses in Asia and America.

38
The Portuguese oppressed by the Spaniards.

Portugal.

as fell out to the marquis of Marialva and others. The forms of proceeding, the jurisdiction, the ministers, the secretaries, were all changed, in the council of Portugal; being reduced from five to three, then two, and at last to a single person.

39
A revolution in favour of the duke of Braganza.

By reason of these and many other grievances too tedious to be mentioned here, the detestation of the Spanish government became universal; and in 1640 a revolution took place, in which John duke of Braganza was declared king, by the title of John IV. This revolution, as being determined by the almost unanimous voice of the nation, was attended with very little effusion of blood; neither were all the efforts of the king of Spain able to regain his authority. Several attempts indeed were made for this purpose. The first battle was fought in the year 1644, between a Portuguese army of 6000 foot and 1100 horse, and a Spanish army of nearly the same number. The latter were entirely defeated; which contributed greatly to establish the affairs of Portugal on a firm basis. The king carried on a defensive war during the remainder of his life; but after his death, which happened in 1655, the war was renewed with great vigour.

40
Perilous state of Portugal on his death.

This was what the Spaniards did not expect; for they expressed a very indecent kind of joy at his death, hoping that it would be followed by a dissolution of the government. It is not indeed easy to conceive a kingdom left in more perilous circumstances than Portugal was at this time:—The king Don Alonzo Enriquez, a child not more than 13 years of age, reputed of no very sound constitution either in body or mind; the regency in a woman, and that woman a Castilian; the nation involved in a war, and this respecting the title to the crown; the nobility, some of them secretly disaffected to the reigning family, and almost all of them embarked in feuds and contentions with each other; so that the queen scarce knew who to trust or how she should be obeyed. She acted, however, with great vigour and prudence. By marrying her only daughter the princess Catharine to Charles II. King of Great Britain, she procured to Portugal the protection of the English fleets, with reinforcements of some thousands of horse and foot; and at last, in 1665, terminated the war by the glorious victory of Montefclaros. This decisive action broke the power of the Spaniards, and fixed the fate of the kingdom, though not of the king, of Portugal. Alonzo was a prince whose education had been neglected in his youth, who was devoted to vulgar amusements and mean company, and whom the queen for these reasons wished to deprive of the crown, that she might place it on the head of his younger brother Don Pedro. To accomplish this purpose, she attempted every method of stern authority and secret artifice; but she attempted them all in vain. The Portuguese would not consent to set aside the rights of primogeniture, and involve the kingdom in all the miseries attending a disputed succession. After the death, however, of the queen-mother, the infant entered into cabals against the king of a much more dangerous nature than any that she had carried on. Alonzo had married the princess of Nemours; but being, as was said, impotent, and likewise less handsome than his brother, that lady transferred her affection to Don Pedro, to whom she lent her assistance to hurl the king from the throne. Alonzo was compelled to sign a resigna-

41
Don Alonzo obliged to resign the throne.

tion of the kingdom; and his brother, after governing Portugal a few months without any legal authority, was in a meeting of the states unanimously proclaimed regent, and vested with all the powers of royalty. Soon after this revolution, for such it may be called, the marriage of the king and queen was declared null by the chapter of Lisbon; and the regent, by a papal dispensation, and with the consent of the states, immediately espoused the lady who had been wife to his brother. He governed, under the appellation of *regent*, 15 years, when, upon the death of the king, he mounted the throne by the title of Don Pedro II. and after a long reign, during which he conducted the affairs of the kingdom with great prudence and vigour, he died on the 9th of December 1706.

Don John V. succeeded his father; and though he was then little more than 17 years of age, he acted with such wisdom and resolution, adhered so steadily to the grand alliance formed against France and Spain, and showed such resources in his own mind, that though he suffered great losses during the war, he obtained such terms of peace at Utrecht, that Portugal was in all respects a gainer by the treaty. The two crowns of Spain and Portugal were not, however, reconciled thoroughly till the year 1737; and from this period they became every day more united, which gave much satisfaction to some courts, and no umbrage to any. In this situation of things, a treaty was made in 1750 with the court of Madrid, by which Nova Colonia, on the river of Plata, was yielded to his Catholic majesty, to the great regret of the Portuguese, as well on account of the value of that settlement, as because they apprehended their possession of the Brasils would by this action be rendered precarious. On the last of July the same year, this monarch, worn out by infirmities, deceased, in the 61st year of his age, and in the 44th of his reign.

Don Joseph, prince of Brasil, succeeded him, to the universal satisfaction of his subjects, and with as great expectations as ever any monarch that mounted the throne. It was generally believed that he would make considerable alterations, in which he did not disappoint the hopes of the public; and yet they were done so slowly, with such moderation, and with so many circumstances of prudence, as hindered all grounds of complaint. Amongst other new regulations, the power of the inquisition suffered some restriction; the king directing, that none of their sentences should be put in execution till reviewed and approved by his privy-council. But as in the reign of his father he had consented to the treaty with Spain, he ratified it after his accession, and since carried it into execution upon this noble principle, that no considerations of interest ought ever to induce a monarch to break his word.

However, within the space of the few years of this king's reign, the calamities of Portugal in general, and those of the city of Lisbon in particular, cannot, in a great degree, be paralleled in all history. An earthquake, a fire, a famine, an assassination-plot against their prince, executions upon executions, the scaffolds and wheels for torture reeking with the noblest blood; imprisonment after imprisonment of the greatest and most distinguished personages; the expulsion of a chief order of ecclesiastics; the invasion of their kingdom by a powerful, stronger, and exasperated nation; the numerous

42
Don John V. a wise and resolute prince.

44
Dreadful calamities during his reign.

rous

Portugal.

them; but a great part of the riches and merchandize brought from these distant countries becomes the property of foreigners, for the goods they furnish the Portuguese with to carry thither. The king's fifth of the gold brought from Brasil amounts commonly to about 300,000*l.* Sterling; so that the whole annual produce of gold in Brasil may be estimated at near 2,000,000 Sterling. Lisbon is the greatest port in Europe next to London and Amsterdam.

49
Constitu-
tion and
govern-
ment.

As to the constitution of Portugal, it is an absolute hereditary monarchy. Both here and in Spain there were anciently cortes, states, or parliaments; but they have long since entirely lost their share in the legislature. For the administration of the civil government, there is a council of state, and several secretaries; for military affairs, a council of war; for the finances, a treasury-court; and for the distribution of justice several high tribunals, with others subordinate to them, in the several districts into which the kingdom is divided. The cities have their particular magistracy. The proceedings of the courts are regulated by the Roman law, the royal edicts, the canon law, and the pope's mandates. Like the Spaniards, they transact most of their business in the mornings and evenings, and sleep at noon. The nobility are very numerous, and many of them are descended from natural sons of the royal family. They are divided into high and low. The high consists of the dukes, marquises, counts, viscounts, and barons, who are also grandees, but of different classes, being suffered to be covered in the king's presence, and having the title of *Dons*, with a pension from the royal treasury, to enable them the better to support their dignity: the king styles them *Illustrious* in his letters, and treats them as princes. A duke's sons are also grandees, and his daughters rank as marchionesses. The inferior nobility or gentry are termed *Hidalgos*, i. e. gentlemen: they cannot assume the title of *Don* without the king's licence.

50
Revenues
of the
king.

The revenues of the crown, since the discovery of the Brasil mines, are very considerable; but the real amount can only be guessed at. Some have said that it amounts, clear of all salaries and pensions, to upwards of 3,000,000 Sterling; others make it a great deal less. Thus much is certain, that the customs and other taxes run excessively high. Besides the royal demesnes, the hereditary estates of the house of Braganza, the monopoly of Brasil snuff, the coinage, the money arising from the sale of indulgencies granted by the pope, the fifth of the gold brought from Brasil, the farm of the Brasil diamonds, the masterships of the orders of knighthood, and other sources, yield very large sums. The forces, notwithstanding, of this nation, both by sea and land, are very inconsiderable; their land-forces being the worst militia in Europe, and their navy of little importance. They would be an easy conquest to the Spaniards if they were not under the protection of Britain.

51
Orders of
knight-
hood.

There are several orders of knighthood here, viz. the order of Christ, the badge of which is a red cross within a white one, and the number of the commanderies 454. 2. The order of St James, the badge of which is a red sword in the shape of a cross. A great number of towns and commanderies belong to this order. 3. The order of Aviz, whose badge is a green cross in form of a lily, and the number of its commanderies 49.

Though these three orders are religious, yet the knights are at liberty to marry. 4. The order of St John, which has also several commanderies.

Portugal
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Portulaca.

The king's titles are, *King of Portugal and the Algarves, on this side and the other side the sea of Africa; Lord of Guinea, and of the navigation, conquests, and commerce, in Ethiopia, Arabia, Persia, India, &c.* The king's eldest son is styled *Prince of Brasil*. In the year 1749, pope Benedict XIV. dignified the king with the title of *His most faithful majesty*.

52
Character-
of the
people.

The Portuguese are represented as inferior to the Spaniards both in person and genius: as extremely haughty, treacherous, and crafty in their dealings; much given to avarice and usury; and vindictive, malicious, and cruel. The meaner sort are said to be extremely addicted to thieving: notwithstanding, it must be owned, that they have shown themselves on many occasions a brave and warlike people. They are justly famed for their skill in navigation; and for the many discoveries they have made, both in the East and West Indies. The women here, and in other countries of the same degree of heat, are not so prolific as in the colder climates; but they are said to be very beautiful whilst young, though their complexion is somewhat upon the olive. Their eyes are very black and sparkling, and retain their brilliancy after all their other charms are gone. It is the fashion here, at present, as in most other countries, for the ladies to spoil and disfigure their skins and complexions with paints and washes: but, though lively and witty, they are said to have a nice sense of female honour. Both men and women make great use of spectacles; often not so much to aid their sight, as to denote their wisdom and gravity. Their dress, like that of the Spaniards, never used to vary, especially among the men; but of late years, both men and women have given much into the French modes. The women, when they go abroad on foot, are wont to use long veils, which cover their heads, but leave their faces bare.

PORTUGALLICA TERRA, earth of Portugal; the name of a fine astringent bole, dug in great plenty in the northern part of Portugal.

PORTULACA, PURSLANE: A genus of the monogynia order, belonging to the dodecandria class of plants; and in the natural method ranking under the 13th order, *Succulentæ*. The corolla is pentapetalous; the calyx bifid; the capsule unilocular, and cut round. There are several species, but the two following are the most remarkable. 1. The oleracea, annual, or common culinary purslane, rises with herbaceous, low, succulent, branchy stalks, six or eight inches high, garnished with wedge-shaped, thick, succulent leaves, and small close-setting flowers. There are two varieties; one with deep green leaves, the other with yellow leaves; both of which rise from the same seed. 2. The anacampseros, perennial, or shrubby cape purslane, rises with a shrubby branchy stalk, about six inches high, with oval, gibbous, succulent leaves, and the stalks terminated by small clusters of red flowers. Both these plants are of a succulent nature: the first is an herbaceous annual, for culinary uses; and the second a shrubby perennial, raised by the curious for variety. They are both exotics of a tender quality, of the temperature of greenhouse or stove plants. The common culinary purslane is raised annually from seed for summer use, and is an excellent ingredient

Portumna
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Pospolite

gredient in summer salads, but improper for winter on account of its cold moist nature. The plant being tender, must be raised either on a hot-bed or in a warm border; in which last it will not succeed before April or May. The shrubby sort must be kept in the hot-house, in pots of a dry soil.

PORTUMNA, a town of Ireland, in the county of Galway and province of Connaught, is 74 miles from Dublin. The castle of Portumna, the seat of the Earl of Clanricarde, is at this place, and near it are the ruins of an ancient castle. There is also a garrison for a troop of horse and two companies of foot. The town is seated on the river Shannon, where it falls into Lough Derg. The monks of the Cistercian abbey of Dunbrody, in the county of Wexford, had for a long time a chapel here, dedicated to St Peter and St Paul; but having at length forsaken it, O'Madden, dynast of the country, gave it to the Dominican friars, who, with the approbation of the monks of Dunbrody, erected a friary here and a church, which they dedicated to the blessed Virgin and the original patron saints; at the same time they built a steeple, and all other necessary offices. Pope Martin V. granted a bull to confirm their possessions, dated 8th October 1426; and on the 23d of November following he granted indulgencies to all who had contributed to the building. The walls are still nearly entire, and show that the monastery of Portumna was by no means an ignoble structure. The ancient choir is now the parish-church.

POSE, in heraldry, denotes a lion, horse, or other beast, standing still, with all his four feet on the ground. See Hollinghead's *Description of Britain*, chap. xvi.

POSITIVE, a term of relation opposed to negative. It is also used in opposition to relative or arbitrary: thus we say, Beauty is no positive thing, but depends on the different tastes of people.

POSITIVE Degree, in grammar, is the adjective in its simple signification, without any comparison.

POSITIVE Electricity. In the Franklinian system all bodies supposed to contain more than their natural quantity of electric matter are said to be *positively* electrified; and those from whom some part of their electricity is supposed to be taken away are said to be electrified *negatively*. These two electricities being first produced, one from glass, the other from amber or rosin, the former was called *vitreous*, the other *resinous*, electricity.

POSPOLITE, in the military establishment of Poland, is the name given to a kind of militia. It is the most numerous and the most useless of the Polish armies.

Goxe's Travels.

It consists of the gentry at large, who, in case of invasion, are assembled by a regular summons from the king, with consent of the diet. Every palatinate is divided into districts, over each of which proper officers are appointed; and every person possessing free and noble tenures is bound to military service, either singly or at the head of a certain number of his retainers, according to the extent and nature of his possessions. The troops thus assembled are obliged only to serve for a limited time, and are not under the necessity of marching beyond the limits of their country. They submit to no discipline but such as they like themselves; and are very apt to mutiny if detained more than a fortnight in the place appointed them to meet in, without march-

ing. The mode of levying and maintaining this army is exactly similar to that practised under the feudal system. At present, though it is almost totally unfit for the purposes of repelling a foreign enemy, it is yet a powerful instrument in the hands of domestic faction: for the expedition with which it is raised under the feudal regulations facilitates the formation of those dangerous confederacies which suddenly start up on the contested election of a sovereign, or whenever the nobles are at variance with each other.

Posse
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Possession.

POSSE COMITATUS, in law, signifies the power of the county, or the aid and assistance of all the knights, gentlemen, yeomen, labourers, servants, apprentices, &c. and all others within the county that are above the age of 15, except women, ecclesiastical persons, and such as are decrepit and infirm.

This posse comitatus is to be raised where a riot is committed, a possession kept upon a forcible entry, or any force of rescue used contrary to the king's writ, or in opposition to the execution of justice; and it is the duty of all sheriffs to assist justices of the peace in the suppression of riots, &c. and to raise the posse comitatus, or to charge any number of men for that purpose.

POSSESSION, in law, is either actual, where a person actually enters into lands or tenements descended or conveyed to him; or where lands are descended to a person, and he has not yet entered into them. A long possession is much favoured by the law as an argument of right, even though no deed can be shown, and it is more regarded than an ancient deed without possession.

If he that is out of possession of land brings an action, he must prove an undeniable title to it; and when a person would recover any thing of another, it is not sufficient to destroy the title of the person in possession without he can prove that his own right is better than his.

In order to make possession lawful upon an entry, the former possessor and his servants are to be removed from off the premises entered on: but a person by lease and release is in possession without making any entry upon the lands.

POSSESSION, in Scots law. See LAW, Part III. No° clxii. 11, &c.

DEMONIACAL POSSESSION. (See DEMON and DEMON-ACS.) In the third volume of the Manchester Transactions, there is a paper on *popular illusions* or medical demonology by Dr Ferriar. He informs us in a note, that, on the 13th of June 1788, George Lukins of Yatton in Somersetshire was exorcised in the temple church at Bristol, and delivered from the possession of seven devils by the efforts of seven clergymen. An account of his deliverance was published in several of the public papers, authenticated by the Reverend Mr Easterbrook, vicar of the temple church in Bristol.—Dr Ferriar gives us the following particulars, extracted from this account, which we shall here insert.

“ Lukins was first attacked by a kind of epileptic fit, when he was going about acting Christmas plays, or mummeries: this he ascribed to a blow given by an invisible hand. He was afterwards seized by fits; during which he declared, with a roaring voice, that he was the devil, and sung different songs in a variety of keys. The fits always began and ended with a strong agitation

Possession
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Post.

agitation of the right hand. He frequently uttered dreadful execrations during the fits. The whole duration of his disorder was eighteen years.

"At length, viz. in June 1788, he declared that he was possessed by seven devils, and could only be freed by the prayers (*in faith*) of seven clergymen. Accordingly the requisite force was summoned, and the patient sang, swore, laughed, and barked, and treated the company with a ludicrous parody on the *Te Deum*. These astonishing symptoms resisted both hymns and prayers, till a *small, faint, voice* admonished the ministers to adjure. The spirits, after some murmuring, yielded to the adjuration, and the happy patient returned thanks for his wonderful cure. It is remarkable, that during this solemn mockery, the fiend swore 'by his infernal den,' that he would not quit his patient; an oath, I believe, nowhere to be found but in the Pilgrim's Progress, from which Lukins probably got it.

"Very soon after the first relation of this story was published, a person, well acquainted with Lukins, took the trouble of undeceiving the public with regard to his pretended disorder, in a plain, sensible narrative of his conduct. He asserts, that Lukins's first seizure was nothing else than a fit of drunkenness; that he always foretold his fits, and remained sensible during their continuance; that he frequently saw Lukins in his fits, 'in every one of which, except in singing, he performed not more than most active young people can easily do;' that he was detected in an imposture with respect to the clenching of his hands; that after money had been collected for him, he got very suddenly well; that he never had any fits while he was at St George's Hospital in London; nor when visitors were excluded from his lodgings, by desire of the author of the Narrative; and that he was particularly careful never to hurt himself by his exertions during the paroxysm.

"Is it for the credit of this philosophical age, that so bungling an imposture should deceive seven clergymen into a public act of exorcism? This would not have passed even on the authors of the *Malleus Maleficarum*; for they required signs of supernatural agency, such as the suspension of the possessed in the air, without any visible support, or the use of different languages, unknown to the demoniac in his natural state."

POSSESSIVE, in grammar, a term applied to pronouns, which denote the enjoyment or possession of any thing either in particular or in common: as *meus*, "mine;" and *tuus*, "thine."

POSSESSORY ACTION, in Scots law. See LAW, n^o clxxxiii. 18.

POSSIBILITY, in law, is defined to be any thing that is altogether uncertain, or what may or may not be.

POSSIBILITY, also denotes a non-repugnance to existing, in any thing that does not any way exist.

POSSIBLE, is sometimes opposed to real existence, and is understood of a thing, which, though it actually does not exist, yet may exist; as a new star.

POSSIDONIA, (anc. geog.) See POESTUM.

POST, a word derived from the Latin *positus*, "set or placed." It is used in several different meanings, but all of them referring either immediately or remotely to this primitive sense of *position*. Thus the word Post signifies, 1. A stake or piece of timber set upright; 2. A

station, particularly a military station; 3. An office or employment; 4. An operation in book-keeping; 5. A conveyance for letters or dispatches; 6. A particular mode of travelling.

POST, a stake or piece of timber set upright. Posts are used both in building and in fencing ground. In brick-buildings much of the strength of the fabric depends on the nature of the posts; as it is through them that the several parts are sustained and held together. The *corner posts* are called the *principal posts*; those formed into breffummers between principal posts for strengthening the carcase of the house are called the *prick-posts*. Posts which are to be set in the ground ought to be well seasoned and coated to preserve them from rotting; burning the downward end has been recommended as an excellent preservative, but a coating of pitch or tar, particularly the late invented coal-tar, can be most safely relied upon. For the various uses to which posts may be applied, and the form and species of them fittest to be employed in each case, see the articles ARCHITECTURE, JOINING, GARDENING, HOUSE, FENCE, &c. In architecture and sculpture **POSTS** are a term used to denote certain ornaments formed after the manner of rolls or wreathings.

POST, a station, particularly a military station.—Any place where persons are set or placed upon particular occasions may be termed a *post*; but the word in this view is now chiefly restricted to military operations, and means any place or situation where foldiers are stationed. Thus the detachments established in front of the army are termed the *out-posts*, the stations on the wings of the army are said to be the *posts of honour*, as being the most conspicuous and most exposed. But in the operations of a campaign, a post properly signifies any spot of ground capable of lodging foldiers, or any situation, whether fortified or not, where a body of men may make a stand and engage the enemy to advantage. The great advantages of good posts, in carrying on war, as well as the mode of securing them, are only learned by experience. Barbarous nations disdain the choice of posts, or at least are contented with such as immediately fall in their way; they trust solely or chiefly to strength and courage: and hence the fate of a kingdom may be decided by the event of a battle. But enlightened and experienced officers make the choice of posts a principal object of attention. The use of them is chiefly felt in a defensive war against an invading enemy; as by carrying on a war of posts in a country where this can be done to advantage, the most formidable army may be so harassed and reduced, that all its enterprises may be rendered abortive. Indeed in modern times this is so well understood, that pitched battles have become much more rare than formerly, manœuvring and securing of posts being considered as the most essential objects in the conduct of a campaign; a change in the art of war much to the advantage of humanity; skill, conduct, and prudence, having thus obtained the ascendancy over brutal courage and mere bodily strength. In the choice of a post, the general rules to be attended to are, that it be convenient for sending out parties to reconnoitre, surprise, or intercept the enemy; that if possible it have some natural defence, as a wood, a river, or a morass, in front or flank, or at least that it be

Post.

be difficult of access and susceptible of speedy fortification; that it be so situate as to preserve a communication with the main army, and have covered places in the rear to favour a retreat; that it command a view of all the approaches to it, so that the enemy cannot advance unperceived and rest concealed, while the detachment stationed in the post are forced to remain under arms; that it be not commanded by any neighbouring heights; and that it be proportioned in extent to the number of men who are to occupy and defend it. It is not to be expected that all these advantages will often be found united; but those posts ought to be selected which offer the greatest number of them. See *WAR, Index*.

POST, an office or employment. This use of the word is probably derived immediately from the idea of a military station; a post being used to express such offices or employments as are supposed either to expose the holder to attack and opposition, or to require abilities and exertion to fill them. Hence the term is used only for *public* offices, and employments under the government; and were strict propriety of speech always attended to, *posts* would denote those stations only in which duty must be performed. In common language, however, every *public* office or appointment, even though nominal and sinecure, goes under the name of a *post*.

POST, an operation in book-keeping. Posting in book-keeping means simply the transferring an article to the place in which it should be put, and arranging each under its proper head. It is upon this that the whole theory of book-keeping is founded. The Waste-book, which is the groundwork of all subsequent operations, records every transaction exactly in the order in which it occurs. From this the several articles are posted, or transferred into the Journal, which in fact is but a kind of supplementary book to the Waste-book. From the Journal they are posted anew into the Ledger; in which a separate place is appropriated for each person with whom transactions are carried on, and frequently for every separate article about which the business is concerned. The particular mode according to which such transferences are made, may vary according to the nature of the trade carried on; the object is the same in all, to place every article so as that its operations on the general state of the business may be certainly known and distinctly traced. For a full account of the way in which this is done, see *Book-Keeping*.

POST, a conveyance for letters or dispatches.

In the early periods of society, communication between the different parts of a country is rare and difficult, individuals at a distance having little inclination or opportunity for mutual intercourse: when such communication is at any time found necessary, a special messenger must be employed. As order and civilization advance, occasions of correspondence multiply. In particular, the sovereign finds it requisite frequently to transmit orders and laws to every part of the kingdom; and for doing so he makes use of couriers or messengers, to whom he commits the charge of forwarding his dispatches. But without stations in the way, where these couriers can be certain of finding refreshment for themselves and supplies of what may be necessary for carrying them forward, the journey, however urgent and important, must always be retarded, and in many cases

altogether stopped. Experience, therefore, soon pointed out the necessity of ensuring such accommodations, by erecting upon all the great roads houses or stations at convenient intervals, where the messengers might stop, as occasion required, and where too, for the greater convenience, relays of fresh horses should always be in readiness, to enable them to pursue their journey with uninterrupted dispatch. These houses or stations were with great propriety termed *posts*, and the messenger who made use of them a *post*. Though at first, it is probable, the institution was intended solely for the sovereign and the necessities of the state; yet by degrees individuals, seeing the benefit resulting from it, made use of the opportunity to carry on their own correspondence; for which they were willing to pay an allowance to the sovereign. Thus a post-office, of some kind or other, gradually came to be established in every civilized country. Without taking notice of the different means of carrying on correspondence said to have been attempted by pigeons, dogs, and other animals, we can at least trace with certainty the invention of something like regular posts as far back as the ancient Persians. Xenophon assures us, that they were invented by Cyrus on his Scythian expedition, about 500 years before Christ; that the houses at the several stations were sumptuously built, and large enough to contain a number of men and horses; and that every courier on his arrival was obliged to communicate his dispatches to the postmaster, by whom they were immediately forwarded. From the shore of the Egean sea to Susa the capital, there were, according to Herodotus, 111 stages for posts, each a day's journey distant from the preceding.

In what manner posts were established and conducted among the Greeks does not clearly appear; but from the extended commerce carried on, and the frequent communications enjoyed among the different states, there can be no doubt that a regular conveyance, in some form or other, was established.

Though posts were well known among the Romans, yet it is difficult to trace with certainty the period of their introduction. Some writers carry it back to the times of the republic; posts and post-offices, under the names of *statores* and *stationes*, having been then, it is said, established by the senate. Whether this was the case or not, Suetonius assures us that Augustus instituted posts along all the great roads of the empire. At first the dispatches were conveyed from post to post by young men who run on foot, and delivered the dispatch to others at the next stage. By and by Augustus substituted, in room of these, horses and chariots, both for the conveyance of dispatches and the convenience of travelling. His successors continued the same establishment; to the maintenance of which every subject of the empire was obliged to contribute. Post-horses are mentioned in the Theodosian code *de cursu publico*; but these were only the public horses appointed to be kept there for the use of the public messengers, who before this institution seized any that came in their way. At each post-station, according to Procopius, 10 horses and as many postilions were kept, and the usual rate of their travelling was from five to eight stations a-day.

It is to be observed, however, that all these establishments of posts in ancient times were formed as much, if not more, for travelling stations, than for the mere

Post.

Post.

conveyance of letters and dispatches. This latter object, it is true, was thereby secured; but the epistolary correspondence of antiquity was probably at no time so extensive as to require or maintain post-offices on the footing of modern posts, for the mere conveyance of letters. It is in later times only, when the extension of commerce and diffusion of literature gave occasion to frequent communication, that these establishments are to be looked for.

The earliest institution of *posts* that occurs in modern history is about the year 807 by the emperor *Charlemagne*; who, having reduced under his dominion Italy, Germany, and a part of Spain, established three public posts at the public expence, to carry on the communication with these three provinces. The institution of posts, however, like many other institutions of that emperor, dropped at his death, and for a considerable time afterwards no traces of any such establishment are to be found. We cannot indeed discover them with certainty sooner than 1464, when that restless and suspicious prince Louis XI. established posts in France, that he might be the sooner advertised of all that passed in his own or the neighbouring kingdoms. He employed in this service 230 couriers, who delivered the letters at the different stations, and in the various towns through which they passed in their course. Succeeding monarchs created at different times certain offices for the express purpose of superintending the posts; but the frequent changes to which these offices were exposed, prevented for a long time the establishment of any regular system of posts in that kingdom; inasmuch that in 1619 the author of the life of the duke d'Epemon says the packet or letter-office was not yet set up in France. Former establishments, it is probable, were solely for the use of the court, not for the general good of the nation. From France, the institution gradually spread through several other parts of Europe. In Germany, Lewis Hornig assures us they were first introduced by Count Taxis, who settled them at his own expence; in acknowledgment for which the Emperor Matthias in 1616 gave as a fief the office of postmaster to him and his descendants.

In England, the establishment of posts in some form or other appears as early as the reign of Edward III. but the notices concerning them are so vague, that no account can be given of them. In the reign of Edward VI. however, some species of posts must have been set up, as an act of parliament passed in 1548, fixing the rate of post-horses at one penny *per* mile: The post-horses here referred to were, it is probable, chiefly for travelling, and the carriage of letters or packets only an occasional service. In 1581, we find in Camden's *Annals* mention made of a chief postmaster for England being appointed.—How his office was managed, does not clearly appear; the limited state of the correspondence of the country, probably rendered it of trifling consequence. King James I. originally erected a post-office, under the controul of one Matthew de Quester or de l'Equester, for the conveyance of letters to and from foreign parts; which office was afterwards claimed by Lord Stanhope; but was confirmed and continued to William Fritel and Tho. Witherings, by king Charles I. in 1632. Previous to this time, it would appear that private persons were in use to convey letters to and from foreign parts; all such interference with the post-

Post.

master's office is therefore expressly prohibited. King Charles, in 1635, erected a letter-office for England and Scotland, under the direction of the above Thomas Witherings. The rates of postage then established were, two-pence for every single letter for a distance under 80 miles; four-pence from 80 to 140 miles; six-pence above 140 miles. The allowance to the postmasters on the road for horses employed in these posts was fixed at two-pence halfpenny *per* mile for every single horse. All private inland posts were discharged at this time; and in 1637 all private foreign posts were in like manner prohibited. The posts thus established, however, extended only to a few of the principal roads; and the times of transmission were not in every case so certain as they ought to have been.

Witherings was superseded for abuses in the execution of his offices in 1640, and they were sequestrated into the hands of Philip Burlamachy, to be exercised under the care and oversight of the king's principal secretary of state. On the breaking out of the civil war, great confusions and interruptions were necessarily occasioned in the conduct of the letter-office: but it was about that time that the outline of the present more extended and regular plan seems to have been conceived by Mr Edmond Prideaux, who was afterwards appointed attorney-general to the commonwealth. He was chairman of a committee in 1642 for considering the rate of postage to be set upon inland letters; and some time after was appointed postmaster by an ordinance of both houses of parliament; in the execution of which office he first established a *weekly* conveyance of letters into *all* parts of the nation. In 1653, this revenue was farmed for L. 10,000 for England, Scotland, and Ireland; and after the charge of maintaining postmasters, to the amount of L. 7000 *per annum*, was saved to the public. Prideaux's emoluments being considerable, the common council of London endeavoured to erect another post-office in opposition to his; but they were checked by a resolution of the house of commons, declaring that the office of postmaster is, and ought to be, in the sole power and disposal of the parliament. This office was farmed by one Maubey in 1654. In 1656 a new and regular general post-office was erected by the authority of the protector and his parliament, upon nearly the same model that has been ever since adopted, with the following rates of postage: For 80 miles distance, a single letter two pence; for a greater distance, not out of England, three pence; to Scotland, four pence. By an act of parliament passed soon after the restoration in 1660, the regulations settled in 1656 were re-established, and a general post-office similar to the former, but with some improvements, was erected. In 1663 the revenue of the post-office was found to produce L. 21,500 annually. In 1685 it was made over to the king as a branch of his private income, and was then estimated at L. 65,000 *per annum*. The year after the revolution the amount of the post-office revenue was L. 90,504 : 10 : 6. At the union the produce of the English post-office was stated to be L. 101,101. In 1711 the former establishments of separate post-offices for England and Scotland were abolished; and by the stat. 9 Anne, c. 10. one general post-office, and one postmaster-general, was established for the whole united kingdom; and this postmaster was empowered to erect chief letter-offices at *Edinburgh*, at *Dublin*,

Post.

Dublin, at New York, and other proper places in America and the West Indies. The rates of postage were also increased at this time as follows.—In England, for all distances under 80 miles 3 d.; above 80 miles 4 d. From London to Edinburgh 6 d. In Scotland, under 50 miles 2 d.; from 50 to 80 miles 3 d.; above 80 miles 4 d. In Ireland, under 40 miles 2 d.; above 40 miles 4 d.—By the above act all persons, except those employed by the postmaster, were strictly prohibited from conveying letters. That year the gross amount of the post-office was L. 111,461 17s. 10d. The nett amount, on a medium, of the three preceding years, was, in the printed report of the commissioners, for the equivalent stated to be for England, L. 62,000, and for Scotland L. 2000. In 1754 the gross revenue of the post-office for Great Britain amounted to L. 210,663, in 1764 to L. 281,535, and in 1774 to L. 345,321.—The privilege of franking letters had been enjoyed by members of parliament from the first erection of the post-office; the original design of this exemption was, that they might correspond freely with their constituents on the business of the nation. By degrees the privilege came to be shamefully abused, and was carried so far, that it was not uncommon for the servants of members of parliament to procure a number of franks for the purpose of selling them; an abuse which was easily practised, as nothing more was required for a letter's passing free than the subscription of a member on the cover. To restrain these frauds, it was enacted, in 1764, that no letter should pass free unless the whole direction was of the member's writing, and his subscription annexed. Even this was found too great a latitude; and by a new regulation in 1784, no letter was permitted to go free unless the date was marked on the cover in the member's own hand-writing, and the letter put into the post-office the same day. That year the rates of postage were raised in the following proportions: an addition of 1 d. for a single stage; 1 d. from London to Edinburgh; 1 d. for any distance under, and 2 d. for any distance above, 150 miles. An addition to the revenue of L. 120,000 was estimated to arise from these regulations and additional rates. In all the statements of duties upon postage of letters given in this account, the rates mentioned are those upon single letters, double letters pay double, treble letters treble, an ounce weight quadruple postage; all above are charged by the weight in the same proportion.

About the year 1784, a great improvement was made in the mode of conveying the mails, upon a plan first suggested in 1782 by Mr John Palmer. Diligences and stage-coaches, he observed, were established to every town of note in the kingdom; and he proposed that government, instead of sending the mails in the old mode, by a boy on horseback, should contract with the masters of these diligences to carry the mail, along with a guard for its protection. This plan, he showed, would not fail to ensure much more expeditious conveyance, the rate of travelling in diligences being far quicker than the rate of the post; and it was easy to carry it into execution with little additional expence, as the coach owners would have a strong inducement to contract at a cheap rate for conveying the mail, on account of the additional recommendation to passengers their carriages would thereby acquire in point of security, regularity, and dispatch.

VOL. XV. Part II.

Post.

Tho' government heartily approved of this plan, and the public at large were satisfied of its utility; yet, like all new schemes, however beneficial, it met with a strong opposition: it was represented by a number of the oldest and ablest officers in the post-office, not only as impracticable, but dangerous to commerce and the revenue. Notwithstanding of this opposition, however, it was at last established, and gradually extended to many different parts of the kingdom; and, upon a fair comparison, it appeared that the revenue was improved, and the plan itself executed for L. 20,000 *per annum* less than the sum first estimated by Mr Palmer.

The present establishment of the general post-office for Great Britain, consists of two postmasters-general, a secretary, surveyor, comptroller-general, and upwards of 150 assistants and clerks for the head letter office in London; the number of deputy postmasters and other officers through the kingdom is very considerable, but not easy to ascertain with accuracy, as it must frequently vary with the changes made in the establishment of country posts. The total expence of this branch of the revenue in 1788 was L. 149,029, 17s. 2d. the gross produce may now be reckoned at L. 650,000.

The first accounts we have of the establishment of a post-office in Scotland reach no farther back than 1635, when Charles I. erected one both for Scotland and England. The post to Scotland by that appointment was to run night and day, to go from London to Edinburgh and to return in *six* days, taking with it all letters intended for any post-town in or near the road; the rate of postage from London to Edinburgh was 8 d. for a single letter. The expedition with which the post went from London to Edinburgh at this time, is indeed surprising, considering the nature of the roads; perhaps, however, though the king made the regulation that it should go and return in six days, the journey was not always performed in the specified time. During the government of Cromwell, the public post conveyed letters to Scotland as well as England; the postage from London to Scotland was only 4 d. After the Restoration, when the post-office was erected for England, mention is made in the act of parliament of the conveyance of letters to Scotland; and the postage to Berwick is fixed at 3 d. For some time after, however, we find no establishment by act of parliament of an internal post in Scotland. In 1662, a post between Ireland and Scotland was first established; and the privy council gave Robert Main, who was then postmaster-general for Scotland, an allowance of L. 200 Sterling to build a packet-boat for conveying the mail between Portpatrick and Donaghadee: the postage to Ireland was 6 d. In 1669, a post was established to go between Edinburgh and Aberdeen twice a-week, and between Edinburgh and Inverness once a-week: the rate of postage was fixed, for 40 Scots miles 2 d. and for every 20 miles farther an additional penny. These appear to have been the only *public* posts in Scotland at that time; but as they could not suffice for the correspondence of the country, there must have been more, either under the direction of the postmaster, or in the hands of private persons; probably there might be of both kinds. In 1690, an act for the security of the common post was passed, subjecting robbers of the mail to capital punishment. It was not till 1695 that the establishment of the post-office in Scotland received the

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Post.

function of parliament: posts were then appointed for all parts of Scotland; the rates of postage were fixed, for any place within 50 miles of Edinburgh 2 d. between 50 and 100 miles 3 d. all places above 100 miles 4 d. By the same act, a weekly packet to Ireland was established, and L. 60 Sterling annually allowed for that service. Though posts were established in consequence of this act, yet such was their mode of travelling, that they hardly deserved the name. Thus, for instance, the person who set out to carry the mail from Edinburgh to Aberdeen, in place of stopping at the first intermediate stage from Edinburgh, and delivering over the mail to another, to be carried forward, went on with it himself the whole journey, resting two nights by the way, first at Dundee, and next at Montrose.

In this manner the mail was conveyed thrice a-week from Edinburgh to Aberdeen; but between most parts of Scotland the post went only twice, and between some only once a-week. The post-boy generally travelled on foot. Horses were but little used in the service of the post-office.

At the Union, the Scots post-office was farmed for L. 1194: in 1710, the nett amount for Scotland was reckoned to be L. 2000. The epistolary correspondence of Scotland must have been small indeed, when even the rates of postage then established proved so very unproductive. This may perhaps, however, be in part accounted for, by conjecturing, that as private posts had probably prevailed pretty much before 1695, it was long before these were entirely suppressed, the people still adhering to their old conveyances, and difficulties occurring in strictly enforcing the law; the amount of the post-office revenue, therefore, at the two periods above-mentioned probably exhibits a view of only a part of the correspondence of Scotland.

In 1711, it has been already mentioned, one general post-office was established for the whole united kingdom; but the postmaster-general was authorized to erect at Edinburgh a chief letter office for Scotland.—This was accordingly done, and a postmaster-general for North Britain, with other necessary officers, appointed. All the deputy postmasters in Scotland are under his immediate direction, but he himself is under the controul of the postmaster-general for Great Britain. From this head letter office posts were established to the different parts of Scotland.

For many years the post-boys generally travelled on foot, or if on horseback, without a change of horses. It was not till about 1750 that the mail began to be conveyed from stage to stage by different post-boys and fresh horses to the principal places in Scotland, and by foot runners to the rest. The communication between London and Edinburgh was at first but thrice a-week, and so slow, that the mail from London to Edinburgh was upon the road 85 hours, and from Edinburgh to London 131 hours. In 1757, upon a representation from the royal boroughs, regulations were fallen upon, by which the time was shortened to 82 hours in the one case, and 85 in the other. By the extension of Mr Palmer's plan to Scotland, the time has been still farther shortened to about 60 hours in each case.

The establishment of the Scots post-office, which has been gradually enlarged as the state of the country required, consists at present of a postmaster-general, secretary, solicitor, and accountant, with a number of

other clerks and assistants for the head office at Edinburgh; under its management are about 180 deputy-postmasters for the different post-towns through Scotland.

The nett produce of the post-office for Scotland in 1733 was L. 5399, in 1754 L. 8927, in 1757 L. 10,623, in 1760 L. 11,942, in 1776 L. 31,103. In 1788 the gross produce was L. 55,836, the expence L. 22,636, 13 s. 6 d.; in 1793 the gross amount was about L. 64,000, the nett produce about L. 40,000.

Penny-Post, a post established for the benefit of London and other parts adjacent, whereby any letter or parcel under 16 ounces weight, or L. 10 value, is speedily and safely conveyed to and from all places within the bills of mortality, or within 10 miles of the city. It is managed by particular officers, and receiving houses are established in most of the principal streets, for the more convenient transmission of the letters. Some other large towns have instituted similar establishments.

About 20 years ago a penny-post was set up in Edinburgh by an individual, unconnected with the general post-office. It met with but indifferent encouragement for some years, doubts being entertained as to its punctuality in delivering the letters; by degrees, however, it seemed to be advancing in estimation, and was more frequently employed. About a year ago, the general post-office, in virtue of the act of parliament prohibiting the conveyance of letters by any but those employed under the postmaster-general, took the penny-post entirely into its own hands; and at present letters are transmitted from the general post-office to the different quarters of Edinburgh and the suburbs, three or four times a-day.

Post, a particular mode of travelling. A person is said to *travel post*, in contradistinction to common journey travelling, when, in place of going on during his whole journey in the same vehicle, and with the same horses, he stops at different stages, to provide fresh horses or carriages for the sake of greater convenience and expedition. As he thus uses the same mode of travelling that is employed for the common post, he is said to travel post, or in post, *i. e.* in the manner of a post.

In tracing the origin of posts, it has been already remarked, that the more ancient establishments of this kind were fully as much for *travelling stations* as the conveyance of letters. The relays of horses provided at these public stations for the messengers of the prince, were occasionally, by special licence, allowed to be used by other travellers who had sufficient interest at court. Frequent demands of this nature would suggest the expedient of having in readiness supplies of fresh horses or carriages over and above what the *public* service required, to be hired out to other travellers on payment of an adequate price. We find, therefore, that in former times the postmasters alone were in use to let out horses for riding post, the rates of which were fixed in 1548 by a statute of Edward VI. at one penny *per* mile. In what situation the state of the kingdom was with regard to travelling post for more than a century after this period, we cannot now certainly discover; but in the statute re-establishing the post-office in 1660, it is enacted, that none but the postmaster, his deputies, or assigns, shall furnish post-horses for travellers; with a proviso, however, that if he has them not ready in half an hour

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Post.

after being demanded, the traveller shall be at liberty to provide himself elsewhere.

The same prohibition is contained in the act establishing the Scots post-office in 1695, as well as in the subsequent act of Queen Anne, erecting the general office for the united kingdom. It is doubtful, however, whether it ever was strictly enforced. By an explanatory act of 26 Geo. II. the prohibition is confined to post-horses only, and every person declared to be at liberty to furnish carriages of every kind for riding post. This regulation has, in fact, done away the prohibition, as hardly any person now thinks of travelling post except in a carriage.

The rate fixed by the act 1695, in Scotland, for a horse riding post, was three-pence *per* Scotch mile. By the act 9 Anne, c. 10. three-pence a-mile without, and four-pence a-mile with, a guide, was the sum fixed for each horse riding post. The increase of commerce, and necessity for a speedy communication between different parts of the kingdom, have brought the mode of travelling post so much into use, that upon every great road in the kingdom post-chaises are now in readiness at proper distances; and the convenience of posting is enjoyed in Britain to a degree far superior to what is to be met with in any other country whatever.

Posting at last appeared to the legislature a proper object of taxation. In 1779 the first act was passed, imposing duties on horses hired either by themselves or to run in carriages travelling post: the duties were, one penny *per* mile on each horse if hired by the mile or stage, and one shilling *per* day if hired by the day. Every person letting out such horses was also obliged to take out a licence at five shillings *per annum*. These duties were next year repealed, and new duties imposed, of one penny *per* mile on each horse hired by the mile or stage, and 1s. 6d. on each if hired by the day. A number of additional regulations were at the same time enacted for securing these duties. An addition of one halfpenny *per* mile, or three-pence *per* day, for each horse riding post, was imposed in 1785, by Stat. 25 Geo. III. c. 51. The duty is secured, by obliging every letter of horses to deliver to the person hiring them a ticket, expressing the number of horses hired, and either the distance in miles to be travelled, or that the horses are hired by the day, as the case happens to be. These tickets must be delivered to the bar-keeper at the first turnpike through which the traveller passes; and the turnpike-keeper gives, if demanded, what is termed an *exchange* ticket, to be produced at the next turnpike. The stamp-office issues to the person licensed to let post-horses such a number of these tickets as is required, and these must be regularly accounted for by the person to whom they are issued. As an effectual check upon his account, the turnpike-keeper is obliged to return back to the stamp-office all the tickets he takes up from travellers. Evasions are by these means rendered difficult to be practised without running a great risk of detection. In 1787, for the more effectually levying the post-horse duties, a law was passed, authorising the commissioners of the stamp-office to let them to farm by public auction, for a sum not less than the produce in the year ending 1st August 1786.

In the advertisement published by the commissioners in consequence of this law, previous to the receiving proposals for farming them, the total amount of the

Post.

duty for Great Britain is stated to have been, at the period above referred to, L. 119,873. The sum for which that duty was farmed in 1794 amounted in all to L. 140,030, of which the district of North Britain was L. 6000.

Soon after the tax was imposed, considerable difficulties were raised about the meaning of the term *posting*, and what mode of journeying should subject travellers to duty. The old law, Stat. 9 Anne, c. 10. explained posting to be "travelling several stages, and changing horses;" but the acts imposing the posting duties expressly declare, that "every horse hired by the mile or stage shall be deemed to be hired to travel post, although the person hiring the same doth not go several stages upon a post road, or change horses;" and that "every horse hired for a day or less period of time, is chargeable with the duty of three halfpence *per* mile, if the distance be then ascertained; and if the distance be not then ascertained, with 1s. 6d. each horse." Horses hired for any less time than two days are by these acts to be deemed to be hired for a day. An action was brought in 1788, in the court of exchequer at Edinburgh, to determine whether several disputed cases fell under the meaning of the act, and were liable to duty; when the following decisions were given:

Saddle-horses both hired and paid by the mile, and saddle-horses hired originally for an excursion, but afterwards paid by the mile, were found liable to duty according to the number of miles paid for; carriage-horses, where the carriage is hired and paid for only at the usual rate of *outgoing* carriages, and no more, whether the person hiring it does or does not return in it, were found liable to duty only for the number of miles *out*; but if the carriage be hired and paid for, or actually paid for though not originally hired, at the usual rate of carriages employed both to carry out and bring back the same company, the duty was found to be exigible according to the number of miles both out and home taken together. Hackney-coaches in Edinburgh, hired and paid for less than two miles, were found liable to duty for one mile.

No duty was found to be exigible on saddle-horses hired for a mere excursion, and paid for accordingly, where the distance neither is nor can be ascertained; on hackney-coaches employed in the streets for less than a mile, or for an excursion or round of visits merely; and on horses or carriages hired for a journey of three days or more, and paid for accordingly, or paid for at the rate of three days, though the journey should actually be performed in two full travelling days. The general rule of these decisions was, that in every case, except unascertainable distance, or journeys exceeding two days, the mode of travelling fell under the legal definition of posting. The only point that may seem doubtful in the judgments here stated, is that where the duty is found chargeable by the number of miles both going and returning. Yet as the law expressly declares, that horses hired by the mile or stage are to be deemed *posting*, and as the number of miles for which they are hired can only be ascertained by the number paid for, it is clear, that where an addition to the outgoing charge is made on account of bringing back, the person hiring the carriage, the carriage in that case is actually hired and paid for according to the number of miles both out and home, and the duty must fall to be rated accordingly.

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ingly. The doubtful points being now settled by the above decisions, the mode of levying the duty in Scotland has been regulated agreeably to them ever since the matter was thus determined.

POSTERIOR, a term of relation, implying something behind, or that comes after, another. In which sense it is used in opposition to *prior* and *anterior*.

The back and hips are the posterior parts of man. Aristotle has given prior and posterior analytics. A date is posterior to another, when it is later or fresher.

POSTERN, in fortification, a small gate, usually made in the angle of the flank of a bastion, or in that of the curtain, or near the orillon, descending into the ditch; whereby the garrison can march in and out, unperceived by the enemy, either to relieve the works, or to make private sallies, &c.

The word is also used in the general for any private or back-door.

POSTHUMOUS, a child born after the death of his father, or taken out of the body of a dead mother; from whence it is frequently applied to the works of an author not published till after his decease.

POSTIL, a name anciently given to a note in the margin of the Bible, and afterwards to one in any other book posterior to the text.

POSTING, among merchants, the putting an account forward from one book to another, particularly from the journal or waste-book to the ledger. See POST and BOOK-KEEPING.

POSTLIMINIUM, among the Romans, the return of one who had gone to sojourn elsewhere, or had been banished, or taken by an enemy, to his own country or state.

POSTPONING, putting any thing after or behind another with regard to time.

POSTSCRIPT, an article added to a letter or memoir, containing something learnt or recollected after the piece was written.

POSTULATE, in mathematics, &c. is described to be such an easy and self-evident supposition, as needs no explication or illustration to render it intelligible; as that a right line may be drawn from one point to another.

POSTURE, in painting and sculpture, the situation of a figure with regard to the eye, and of the several principal members thereof with regard to one another, whereby its action is expressed. A considerable part of the art of a painter consists in adjusting the postures, in giving the most agreeable ones to his figures, in accommodating them to the characters of the respective figures, and the part each has in the action, and in conducting and in pursuing them through-out.

Postures are either natural or artificial.

Natural postures are such as nature seems to have had a view to in the mechanism of the body, or rather such as the ordinary actions and occasions of life lead us to exhibit while young, and while the joints, muscles, ligaments, &c. are flexible.

Artificial postures, are those which some extraordinary views or studies occasion us to learn; as those of dancing, fencing, &c. Such also are those of our balance and posture masters.

A painter would be strangely puzzled with the figure of Clark (a late famous posture-master in London) in

a history-piece. This man, we are told in the Phil. Transf. had such an absolute command of his muscles, &c. that he could disjoint almost his whole body; so that he imposed on the great surgeon Mullens, who looked upon him as in such a miserable condition, he would not undertake his cure. Though a well-made man, he would appear with all the deformities imaginable; hunch-backed, pot-bellied, sharp-breasted, &c. He disjoined his arms, shoulders, legs, and thighs; and rendered himself such an object of pity, that he has frequently extorted money, in quality of a cripple, from the same company in which he had the minute before been in quality of a comrade. He would make his hips stand a considerable way out from his loins, and so high as to invade the place of his back. Yet his face was the most changeable part about him, and showed more postures than all the rest. Of himself he could exhibit all the uncounted odd faces of a Quaker's meeting.

POTAMOGETON, POND-WEED: A genus of the tetragynia order, belonging to the tetrandria class of plants; and in the natural method ranking under the 15th order, *Inundate*. There is no calyx; but four petals; no style, and four seeds. There are 12 species, all of them floating vegetables on the surfaces of stagnant waters, affording an agreeable shade to fish, and food to cattle.

POTAMON or POTAMO, was a philosopher of Alexandria. He kept a middle course between the scepticism of the Pyrrhonians and the presumption of the dogmatists; but attached himself to none of the schools of philosophy of his time. He was the first projector of the Eclectic sect; for though that mode of philosophizing had been pretty common before, he was the first that attempted to institute a new sect on this principle. "Diogenes Laertius relates, that not long before he wrote his Lives of the Philosophers, an Eclectic sect, *ἐκλεκτικὴ τῶν ἀριστῶν*, had been introduced by Potamo of Alexandria, who selected tenets from every former sect. He then proceeds to quote a few particulars of his system from his Eclectic institutes, respecting the principles of reasoning, and certain general topics of philosophical inquiry; from which nothing further can be learned, than that Potamo endeavoured to reconcile the precepts of Plato with those of other masters. As nothing remains concerning this philosopher besides the brief account just referred to in Laertius, an obscure passage in Suidas, and another still more obscure in Porphyry; it is probable that his attempt to institute a school upon the Eclectic plan proved unsuccessful. The time when Potamo flourished is uncertain. Suidas places him under Augustus; but it is more probable, from the account of Laertius, that he began his undertaking about the close of the second century."

POTASH, the lixivious ashes of certain vegetables, used in making of glass, soap, &c. See GLASS, SOAP, &c.

The method of making potash is directed by Dr Shaw as follows. Burn a quantity of billet-wood to method grey ashes; and taking several pounds of these ashes, of making boil them in water, so as to make a very strong lixivium, potash. or ley. Let this ley be strained through a coarse linen cloth, to keep out any black parts of the half-burnt wood that might happen to remain in the ashes; then evaporate this strained lye in an iron-pan over a quick fire almost to dryness: then taking out the matter remaining

Potamogeton
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Potash.

Enfield's
History of
Philosophy.

Dr Shaw's
method
of making
potash.

Potash.

* See

PEARL-
Ash, and
Trans-
actions of the
Royal Irish
Academy,
1789, art. 1.
Chemical
Science.

remaining at the bottom, and putting it into an iron crucible, set it in a strong fire till the matter is melted, and then immediately pour it out upon an iron-plate, where it soon cools, and appears in the form of a solid lump of potash *. Much after this manner is pot-ash made in the large way of business, for the service of the soap-boiler, glass-maker, fuller, &c. but according to the difference of the wood, or combustible matter employed, with the manner of turning it, and conducting the process, different kinds of potash are prepared. There are certain saline plants that yield this potash to great advantage, as particularly the plant kali; there are others that afford it in less plenty, and of an inferior quality, as bean-stalks, &c. but in general, all vegetable subjects afford it of one kind or other, and may most of them be made to yield it tolerably perfect after the manner of the process already laid down, even the loppings, roots, and refuse parts of ordinary trees, vine clippings, &c. The fixed salts of all vegetables excepting the kali and marine plants, when reduced to absolute purity, or entirely separated from the other principles, appear to be one and the same thing: whence it should seem, says Dr Shaw, that by a suitable management, good saleable potash might be made in all places where vegetable matters abound. For if by examining Russia (A) potash, for example, we find that its superior excellence depends upon its being clear of earth, or upon its containing a large proportion of oil, or refined salt, these advantages may, by properly regulating the operation, be given to English potashes, so as perhaps to render the latter as good as the former: but where the potash of any remarkable saline vegetable is to be imitated, that of the kali, for example, the Doctor recommends a prudent sprinkling of the subject with salt, or sea-water, in the burning; and by these ways, properly diversified, any principle that is naturally wanting might be artificially introduced so as to perfect the art of potash.

2
Account of
Mr Stephens's
manufacture.

Plate
CCCXV.

About 40 years ago or upwards, Mr Stephens, encouraged by the Society of Arts, &c. and by a parliamentary grant of 3000*l.* established a manufacture of pot-ash in North America, which produced such as was so perfectly good as to answer in bleaching and other uses the purposes of *pearl-ash*; and which at the same time afforded a very large produce. But the very great heat which his process required, occasioned the destruction of a very extensive apparatus; and other circumstances concurred to disappoint the hopes and check the spirit of the proprietors. The manufacture was, however, afterwards undertaken and prosecuted by others. Mr Stephens's apparatus was as follows: Fig. 1. A is the bed of the kiln, which lies off about four feet by

two from the grate, more or less according to the size; C is the ash-hole, 2½ or 3 feet deep. Fig. 2. B represents quadrangular bars of iron, with their opposite angles placed upwards and downwards, not above an inch asunder. Fig. 3. A, B, and C, are three steepers five feet deep, and of any width from four to eight feet square, of the best white pine or cyprus plank, with square joints and strong oak frames, placed each over a receiver, with a cock to let off the lye, and a vent just beneath the surface of the grating. E represents three receivers, standing each under, and projecting out, from its steeper. They must be made of the best stuff, carefully put together, and laid in tough clay well rammed within the ground, their tops being level with the surface: they need not be so large as the steepers by six, eight, or twelve inches. Fig. 4. E represents a false bottom or lattice of boards, eight inches deep and five square, with a hole in the under edge of every partition for the lye to pass into the steeper. Fig. 5. A is the vessel over the furnace in which the lye and ashes are mixed; B is a hole or funnel a few inches from the back of the furnace, with an iron socket to let the pipe through the hinder part of the arch, to reach down within two inches of the floor of the furnace. C is a cast iron cauldron for boiling the lye to dryness when pearl-ash is made. D is a vessel whence the liquor is let into the cauldron as it evaporates. The mortar for building the furnace should be made of loam; the arch should be 18 inches thick, and the floor should be laid with tiles on a layer of sand an inch thick, with neat joints.

Mr Stephens's process, both with and without the kiln, was as follows. Cut timber, felled at any season, into lengths of about eight feet; lay from three to ten of them lengthwise in a heap upon dry ground, and fill the vacancies between with smaller wood: the sooner it is burnt after felling, the better. Set fire to it by laying embers on the bottom logs at each end; and for burning the brush and lappings, with other smaller woods, lay them lengthwise on the ground, top to top, lapping over a little, with the butt ends outwards, and as close as a faggot; laying the larger woods on top till the heap is full four feet high; the length of the brush set against each other making the breadth of the heap. As to the choice of the timber, old hollow trees, if not dead, are best: pine, cyprus, and cedar, are to be totally rejected.

As soon as the pile is burnt down, rake such ashes as lie round the outside a little in towards the middle; add no fresh fuel, nor throw on any brands. Let the ashes lie without stirring till you can just bear your hand in them: then carry them to a house, or under a shed, on a plank floor raised a little from the earth and well jointed;

4
Process
without
using a
kiln,

(A) According to Sir Peter Warren, the best woods for making Russia potash are, oak, ash, poplar, hickory, elm, hazle, and beech. They must be cut in November, December, January, and February, split and stacked to dry. After 12 months in warm open weather, it must be burnt on a brick hearth by a slow fire in a kiln, or close place; the ashes must be sifted through two sieves, one finer than the other, and then put up in brick troughs or wooden backs, covered with rain or river water, and must remain well marshed and incorporated five months. Brick furnaces shaped like bakers ovens must be heated with a strong fire of oak or ash, burning night and day; the prepared ashes must be gradually thrown on the fire, when they will run into metal like lead: the fire must not go out till the furnace is high filled with potashes. The ashes must then be broken to be taken out, but the larger the pieces the better; they must be preserved from the air in tight casks, the large pieces by themselves, and the dust by itself.

Potash.

jointed; there wet them till brought nearly to the consistence of mortar in the first mixture of lime and sand, and ram them in a heap, in which they must lie full 20 days, or some months if you please; observing to be more sparing of water in winter, and ramming them closer, and sometimes wetting the top that it may never grow quite dry.

5
And with
it.

Plate
COCUXV.

Wood may also be burnt in a kiln, as fig. 1 and 2; and then it must be cut into such lengths as may be most convenient for carriage, and best suit the size of the kiln. The mouth of the ash-hole must be close stopped by daubing the joints of the lid with loam, or throwing a bank of sand or earth against it: keep the bed of the kiln filled with wood up to the surface, but not above it, and let it burn incessantly till the ashes rise within six or eight inches of the grate. Draw them out whilst red-hot, and in that state sprinkle them with lye, from four to six carats weight; weigh a small vial which holds about four ounces very exactly; then fill it with water and weigh that also: divide the weight of water into equal parts till you come to $\frac{1}{128}$ of the whole, which is called a *carat*, $\frac{1}{8}$ two carats, &c. until you have a weight equal to $\frac{1}{4}$ of the whole water, which is called 32 carats: all which small weights, together with one equal to the phial filled with water, are to be kept for weighing the lye in the said phial till they are made damp; then ram them as before in a heap, but separate from the ashes made as above. N. B. By kiln-burning a stronger lye may be more certainly procured than by the other way, where rain may chance to fall on the ashes before they can be removed.

The ashes thus prepared are to be put in vats or steepers fig. 3, with a false latticed bottom as fig. 4; first putting coarse wheat or rye straw about a foot thick on the lattice or grating; on which put ashes to within four or five inches of the top, ramming them all the way up, especially at the sides, with a small light rammer, as tight as you can, without bursting the vat. Form on the top of the steeper a hollow basin in the ashes four or five inches deep, leaving the ashes four or five inches thick on the sides, by raising a small bank round the sides, so that the liquor may not overflow the edges of the ashes at top: keep this basin constantly filled with soft water in the steeper A, until the ashes will imbibe no more, which will be in 24 hours or more, according as it is rammed; then turn the cock, and let off what shall be soaked through into the receiver or lower chamber of the steeper, and no more; for if the several runnings are not kept separate, the lye will not be brought to its due strength. Follow that steeper with fresh water on the same ashes for several other runnings, which will each come off in a few days, till the liquor has neither smell nor taste; then heave out the ashes, and charge the steeper afresh.

Upon drawing off the first running from the steeper A, fig. 3, fill the steeper B with ashes as before, and put into its hollow at the top the lye so first run off, and the smaller or half lyes also, till full, and draw off as directed for the steeper A: if this weighs 18 carats or more, pump it into the cistern F as fit for use; if it be short of that, pass it off as half lye to the steeper C, and through fresh ashes till strong enough. With kiln-ashes only, from water passing through the first steeper, it will be strong enough for the cistern, if the ashes are well prepared. If your water be hard, let it stand two

or three days exposed to the air and sun in a shallow back, and it will be soft. When you use kiln-ashes with others, lay them at bottom.

The lye must be conveyed from the cistern F, as it is wanted to the vessel A fig. 5; where with every gallon of proof lye mix three ounces of fine, light, wood ashes; and to the lye that is $\frac{1}{4}$ over-proof put six ounces of ashes; and if $\frac{1}{2}$ over-proof 12 ounces, increasing or lessening according to the strength of the lye.

For evaporating the lye and melting the salt, heat a furnace till you bring it very near a white heat, of which the side-doors being red-hot is a mark. This will take 48 hours or more, if the furnace be quite cold; when thorough hot, a little fuel keeps it so. Then, through the cock of the vessel A, pass the mixture by the funnel B into the furnace, not so as to reach much beyond the middle of the floor, before it changes from dark to bright red, letting the heat prevail towards front or back as you see necessary. When the mass begins to gather about the flues or in heaps, run in no more till the furnace is cleared by driving the fire backward. You must have two funnels, one soon choaking: in an hour or less will issue out a red-hot stream of melted salt, which is potash, to be broke to pieces as soon as cold, and packed in tight close casks, being in no respect inferior to the best foreign ash whatever.

The best potash is made from barilla, and comes from ⁶Spanish Spain. The plants from which it is procured are found ^{best} in great plenty about Carthage, where they are indigenous, and may be collected in a swamp called *Almojar* east of that place; the *Sayones* barilla is the best. They are found, besides all along that coast, on the borders of the Mediterranean for 60 leagues in length and 8 in breadth. About 150,000 quintals of it are annually exported from Spain. It produces a revenue of 25,500l. a year; each quintal paying a duty of 17 reals: yet Don Bernardo de Ulloa, A. D. 1740, says it was farmed at L. 1822, 4s. 3d. M. Macdonnell has brought the manufacture of potash to its present perfection in Spain; but its exportation is materially injured by the heavy tax on it. See Townshend's *Travels*, vol. iii. p. 131. See also BARILLA, KELP, and FUCUS.

In the 70th volume of the Philosophical Transactions ⁷Dr Percival's account of making potash. we have an account of a method of procuring this salt from the putrid water which runs from dunghills. The process is very easy, consisting only in simple evaporation of the fluid, and calcining the impure salt till most of the foulness is burnt out. From 24 wine-pipes full of this muck-water were obtained 9 cwt. 1 q. 12 lb of saleable potash, valued at 42 s. per cwt; the expence of manufacturing them being only valued at 4 l. 9 s.

The potash thus made is of a greyish white appearance; deliquesces a little in moist air; but if kept in a dry room, near the fire, acquires a powdery surface. It is hard and of a spongy texture when broken, with many small crystals in its substance. The colour of its internal parts is dusky and variegated. To the taste it is acrid, saline, and sulphureous. It emits no smell of volatile alkali, either in a solid form, dissolved, or when added to lime-water; neither does it communicate the sapphire-colour to a solution of blue vitriol. Silver is quickly tinged black by it; a proof that it contains much phlogiston. Ten grains of this potash required 11 drops of the weak spirit of vitriol to separate it.

The

Potash.

Potash.

The like quantity of salt of tartar required 24 drops: a strong effervescence occurred in both mixtures; and a sulphureous vapour exhaled from the former. A tea spoonful of the syrup of violets diluted with an ounce of water was changed into a bright green colour by five grains of the salt of tartar; but ten grains of this potash were necessary to produce the same hue in a similar mixture. Half an ounce of the salt dissolved entirely in half a pint of hot water; but when the liquor was cold, a large purple sediment subsided to the bottom; and it was found that this sediment amounted to about two-thirds of the whole quantity of ashes used.

Dr Percival, the author of this paper, concludes with observing, that this potash is a true fixed vegetable alkali, produced by putrefaction; that the quantity of alkali contained in it may be estimated at one-third of its weight, whereas the white Muscovy ashes are said to yield only one-eighth part; that no quicklime appears to be contained in this potash, for a solution of it poured from its sediment remained clear though long exposed to the air: that it would be worth trying, whether the large purple sediment, which subsides when this potash is lixiviated, might not be applied to the manufacture of Prussian blue, or used in the manner recommended by Macquer for dyeing wool and silks; and that this manufacture will furnish the farmer for top-dressing for his garden and land, of great fertilizing powers. See *Phil. Transf.* Vol. LXX. p. 345.

These are the processes most essentially different from one another which have appeared concerning the manufacture of this useful salt. Some indeed have attempted to compose it on the supposition that alkali consisted of an earth combined in a peculiar manner with a certain acid. But the little success of all these attempts shew that they have been built on a false principle. The only method of producing alkaline salts originally is from the ashes of vegetables; and the vegetable substances which yield the largest quantity of them are tartar and marine plants. From the former the purest and strongest vegetable alkali is obtained, and from the latter the mineral alkali. From other vegetables, as fern, broom, bean-stalks, &c. an alkaline salt is produced, but so impure, and in such small quantity, that no manufacture of it can be established in this country with any reasonable expectations of profit.

Dr Watson (the present bishop of Landaff) suggests, that the investigation of a method of extracting its alkaline part from rock salt would be a most serviceable discovery. We have inexhaustible mines of rock salt in this country, which (he observes) the proprietors can afford at ten shillings a ton. A ton of rock-salt contains about half a ton of mineral alkali, which is for most purposes far preferable to potash. To those who have leisure to attempt such a discovery, he gives the following hint: whether the alkaline part of rock-salt may not be obtained by calcining it in conjunction with charcoal in open fires? His reason for this conjecture is founded upon the following experiment: upon burning sea-wreck to a black coal and stopping the process at that point, he has obtained great plenty of common salt, but no mineral alkali from the black ashes; though we are certain, that when the black ashes are thoroughly calcined, or reduced to white ashes, mineral alkali may be obtained from them. This makes it probable, that the common salt contained in the black ashes o

sea-wreck is decomposed, and changed into a mineral alkali, during the burning of the black ashes. There are reasons to suppose, that the cinder of pit-coal would answer the purpose better than charcoal. *Chem. Ess.* vol. i. p. 136, &c.

The potashes of different countries vary much in quality; and the experiments of Dr Home, in his treatise on Bleaching, seem to set forth their different properties in the clearest point of view. The different kinds tried by him were;

1. *Blue pearl-ashes.* These appear to be a pure alkaline salt, mixed with a small quantity of vitriolated tartar and earth. Half a pound of this, filtered and evaporated, yielded $5\frac{1}{2}$ ounces of pure salt.—Here, however, we must observe, that though the quantity was so far diminished by this operation, yet we are not to imagine that the whole of this diminution was owing to impurities; for all salts are destroyed in some measure by solution in water and exsiccation.

2. *White pearl-ashes* are nearly of the same quality with the former; half a pound of them giving five ounces and seven drams of pure salt, with some vitriolated tartar and earth.

3. *Russia or Muscovy ashes* have very much the appearance of slacked lime, and are, like it, friable betwixt the fingers. They adhere to the tongue; and their alkaline taste soon goes away, leaving in the mouth a strong taste of lime. Some small bits of charcoal are observable in their composition, and they never turn moist in the air. Half a pound of the salt lixiviated with water and evaporated, gave only 10 drams 15 grains of very caustic salt. These consist therefore of a small quantity of alkaline salt united with a large quantity of lime.

4. *Cashub-ashes* are of the colour of iron stone, and extremely hard, with many shining particles of charcoal in them. They have a saline taste, with a considerable degree of pungency; feel gritty in the mouth when broke in pieces by the teeth; and will dissolve in water. To extract the pure salt, half a pound of the ashes were boiled in a pint of water; then that water poured off, and half a pint put on the ashes again; and so on, till the ashes tasted no more salt. This boiling took 24 hours, and the last water that came off had a strong taste of sulphur, and was blackish. A piece of silver put in the decoction was in a few minutes turned almost black; but though the decoction was evaporated considerably, it did not turn silver black more speedily than before. The whole, when totally evaporated, yielded only 10 drams of a brown salt having a strong caustic alkaline taste. Some Cashub-ashes powdered, and often washed in water so that the salts were all carried off, were infused in water. After standing some time, there was a weak lime-water, with something of a saline taste, but no pellicle. Some of this residuum was put into a reverberatory furnace for two hours; after which it afforded good lime-water. Cashub-ashes then appear to contain an earth half vitrified, some lime, alkaline salts, and a quantity of sulphur.

5. *Marcast ashes* are of a paler colour than the former, with some small pieces of charcoal in their composition. They have a strong saline taste; and so great pungency, that they cannot be held long in the mouth. Half a pound dissolved in water, filtered and evaporated, yielded 11 drams one scruple and two grains of alkaline.

Potash.

Dr Home's experiments on the potashes of different countries

8

Other at tempts.

9

On extracting its alkaline part from rock-salt.

Potash.
11
On manu-
facturing
them in
this coun-
try.

kaline residuum. The decoction blackened silver, but not so strongly as the former; and by evaporation it quickly lost that quality.

Our author next proceeds to consider the probability of manufacturing these ashes in this country. On which subject he has the following observations.—"The blue and white pearl-ashes we have discovered to be pure alkaline salts, without any considerable mixture of heterogeneous bodies. Their purity shows the lixive to have been strained through some close substance, such as linen or flannel. The blue ashes show by their colour that they have sustained the most fire. But both of them are so much alike, that the one may be substituted for the other; and therefore we shall consider them in one view.

"Every one knows that alkaline salts, such as these, are got from all plants except the alkalescent, and from all trees except the most resinous, which afford them in very small quantity. These plants or trees, when found, are pulled or felled in the spring, dried, and burnt to ashes. By the affusion of warm water the salts are dissolved, and, by straining, separated from the earth along with the water. This saline liquor, which is called a *lixive*, is evaporated over a fire; and what remains is an alkaline salt of the same kind with the pearl-ashes.

"I was informed by a skilful bleacher in Ireland, that he practised a more expeditious way of extracting the salts. He bought the ashes of different vegetables from the commonalty for 9 s. a bushel. From these a very strong lye was made, into which dry straw was dipped until it sucked up all the lye. This straw was afterwards dried and burnt, and gave him salts which he showed me, almost as good and pure as the pearl-ashes. This method I have several times tried; but could never burn the straw to white ashes, the salts diminishing the inflammability of the straw. It is a very expeditious method if it can be practised. But I can see no occasion for bringing the lye into a solid form, as the salts must again be dissolved in water before they can be used. The strength of the lye can easily be determined by the hydrostatical balance.

"Though I make no question, that the quantity of salt, in plants of the same species, will vary in different soils and climates; yet it would be of advantage to have the proportion ascertained in general. Some trials of this kind I have made.

"Two pounds of fern which had been pulled August 16. were dried, and burnt to white ashes. These weighed 7 dr. and tasted very salt. When lixiviated, strained, and evaporated, they gave me 49 gr. of salt, about the eighth part of the ashes. If the fern had been pulled in April, it would have afforded more salt. Why then should we not prepare salts from this vegetable? There is more of it growing on our hills than would serve all our bleachfields. The Irish make great use of it.

"From 11 oz. of tobacco-ashes I had 1 oz. of salt. Two ounces of peat-ashes afforded half a drachm of

Potash. salt. Nettles, I am informed, afford much salt. Furz and broom, natives of this country, are very fit for this purpose.

"But the kelp, as it grows in such plenty along our shore, and contains more salt than any other vegetable I know, would be the most proper, were it not for a mixture of some substance that renders it unfit for bleaching, at least of fine cloths, after they have obtained a tolerable degree of whiteness. It is observed by bleachers, that, in these circumstances, it leaves a great yellowness in the linen. As these ashes are much used in Ireland, and as it is not uncommon to bleach coarse cloths with them in Scotland, a disquisition into their nature, and some attempts to purify them, may not be improper. There are no ashes sold so cheap as these; for the best gives but 2 l. the 2000 weight (B). They may, therefore, allow of more labour to be expended on them, and come cheaper at long-run than the foreign salts.

"I dried some sea-ware, and burnt it, though I found that last operation very difficult. When I had kept it fused in the fire for two hours, it weighed 3½ oz. I poured on the ashes an English pint and a half of cold water, that I might have as little of the sulphur as possible. This lye, after it had stood for some hours, was poured off clear, and had but a slight tendency to a green colour. I made a second infusion with milk-warm water, and poured it off from the sediment. This had a darker colour than the former; was kept separated from it, and evaporated by itself. There was a third infusion made; but having no salt taste, it was thrown away. The second infusion seemed to contain more sulphur than the first; and a piece of white linen kept in it half an hour, while it was boiling, was tinged yellow, and could not be washed white again. The earthy part remaining, weighed, when well dried, 1 oz. 2 dr. The saline decoction evaporated by degrees, and set at different times in a cellar to crystallize, afforded me 5 dr. 46 gr. The liquor, when entirely evaporated, left 4½ dr. of a yellow salt, which appeared to be a strong alkaline. The salts which crystallized seemed to be mostly sea-salt, with a considerable quantity of sulphur, and some alkaline salt. There appeared no signs of the bitter in these salts, as their solution did not turn turbid with the oil of tartar. Nor is any of the bitter to be expected in kelp ashes, although it probably is to be found in the recent vegetable; because the alkaline salts formed by the fire must have changed it into a neutral. The lye made warm with water, being evaporated, left 4 dr. of a black bitter salt, which, from its quantity of sulphur, appeared unfit for bleaching. These ashes, then, seem to be a composition of somewhat less than the fourth of sulphur, the same quantity of sea-salt, about a fourth of alkaline salt, and somewhat more than a fourth of earth. The alkaline salt contained in kelp ashes amounts to one penny a pound. This cheapness makes it worth our pains to bestow some labour on them.

"If the bad effects in bleaching with kelp-ashes arise from

(B) "Since this treatise was written, however, the price of kelp has been advanced to 7 l. or upwards the 2000 weight; so that those who would now attempt any thing of this kind, must also manufacture the kelp themselves."

Potash.

from the sea-salt, as some of the most knowing bleachers think, they can be freed from it in an easy manner. Let a lixive of kelp-ashes be made with cold water, for that does not extract so much of the sulphur; it must stand but for a short time, for these salts dissolve easily; decant it, and evaporate the lye. As the boiling continues, the sea-salt will crystallize. When that is all separated, the remaining lye will contain alkaline salt with some sulphur. This operation every master of a bleachfield may learn and oversee, without taking up much of his time. A similar process is carried on by common servants in the alum-works, who have by practice learned it from others.

"I had some hopes that the sulphur might be carried off by long roasting, such as these salts undergo before they are fused in order to be turned into glass; because I had observed, that the longer time they were kept in the fire, the freer were they from this sulphureous part.

"I ordered a quantity of kelp ashes to be kept in the furnace of a glasshouse, where the heat was just below the vitrifying point, for 24 hours. During this time they had lost almost four-fifths of their weight. They were now much freer from their sulphur, and were of a light colour; but much of the alkaline salt had been driven off with the oils. If a lye is much impregnated with this sulphureous matter, it appears to be carried off in a great measure by long boiling.

"We come now to explain the method of manufacturing the white Muscovy ashes. We have shown, by undoubted experiments, that the greatest part of these ashes consists of lime; and yet we have several acts of parliament which forbid the use of that material under severe penalties. The parliament were in the right to discharge its use, upon the disadvantageous reports which were made to them. We shall immediately see how dangerous a material it is when used improperly, or without the mixture of alkaline salts, which render it safe, and more soluble in water. But I will venture to say, that experiment will not support the prejudice entertained with regard to it, if carried any further.

"Since bleaching, then, cannot be carried on without it (for those ashes which contain it are quite necessary in that operation), and since we import them from foreign countries, let these prejudices against it cease, and let us only consider how we may render our own lime as safe as the foreign. If we can do that, the wisdom of the legislature will be as ready to abrogate these acts as they were to make them.

"By my experiments on the white Muscovy ashes, I got about the eighth part of alkaline salts from them. This made me expect, that, by mixing in the same proportion quicklime and alkaline salts, I should be able to produce Muscovy ashes.

"To an ounce of quicklime and a drachm of white pearl ashes, I added about a gill of water, and boiled them together till the water was all evaporated. The taste of this substance was little different from lime. To recover the salts again from the lime, I dissolved it in water, strained off the liquor, and evaporated it. Instead of the drachm of salts, I had but 2 gr. of a substance which was more earthly than saline.

"To 3 dr. of quicklime, and as much potashes, I added a mutchkin of water, and kept it boiling for two

hours till it was evaporated. I dissolved it again in water, which being filtered and evaporated, gave me $1\frac{1}{2}$ dr. of a caustic salt, that liquefied in the air when it had been but four minutes from the fire. It appears, then, that the alkaline salts are destroyed by lime, and that a great part of them can never be again recovered. From the remaining lime, after the salts were extracted, I got strong lime-water, but without a pellicle. This shows, that a quantity of alkaline salts, equal to the lime, boiled with it for two hours, are not able to fix all the soluble part of the lime.

"From these experiments we may draw some corollaries with regard to the present subject. 1st, That evaporating the water from the lime and salts by boiling, is a most unfrugal way of preparing these white ashes. 2^{dly}, That these ashes ought to be kept close shut up in casks; for if exposed to the open air, though in a room, the alternate moisture and drought must fix their most useful parts. This I have found to be fact: for the salts that I made became less pungent by keeping; and I have observed, that the surface of the Muscovy ashes lost all pungency by being exposed to the air, while their internal parts still retained it. 3^{dly}, That all boiling is prejudicial to these Muscovy ashes, as it fixes, and that quickly, their most subtle and probably their most serviceable parts.

"Let us now proceed to another method of making these white ashes. I imagined, that if the salts were dissolved in water, and the quicklime slacked with that, the mass would soon dry without the assistance of fire. In this way I added equal parts of both; but the composition was so strong, that it blistered my tongue if it but touched it. When the fourth part was alkaline salt, it blistered my tongue when kept to it a few seconds. I could taste the salts plainly in the composition, when they made but the thirty-second part of the whole.

"I thought, when composed with the eighteenth part of salt, it had, when fresh made, just the taste and look of the Muscovy ashes; nor could any person have distinguished them. This I once imagined was the proportion; but when I found that the saline pungency soon turned weaker by keeping, and that this composition would not afford the same quantity of salts that the Muscovy ashes did, I saw that a much greater quantity of salts was necessary. The proportion appears to be one of salt to four of lime, prepared in this last way. Three drachms of ashes prepared in this way, and kept for a fortnight, gave me but 15 grains of salt; which is but the half of what the Muscovy would have afforded. I find, if the quicklime is first quenched, it does not fix the salts so much; and therefore is better and cheaper. One drachm of potashes dissolved in a little water, and added to 3 drachms of quenched lime, gave me 44 grains of a very caustic salt. I prefer this method as the best.

"The manufacturers of this salt probably pour the lixive upon the lime, as they can know by its specific gravity what quantity of salts is in the water, and so save themselves the expence of procuring the salts in a dry form.

"The manufacture of the Marcott and Cashub ashes remains yet to be explained. We have discovered that both of them contain sulphur, earth, alkaline salts, and

Potash.

Potash. lime; and differ in nothing but in the Cashub's having more sulphur than the Marcott ashes. We shall therefore consider them together.

"Whether these two species of ashes are of any use in bleaching, may be, and has already been, disputed. I find they contain no other principles, the sulphureous part excepted, than the former ashes combined together. Why then should we expect any other effects from the same ingredients in the Marcott and Cashub ashes, than what we have from either of the pearl and Muscovy ashes mixed together? The sulphureous principle in the former must have very bad effects; as I find by experiment, that it leaves a yellowness on cloth that is very hard to be washed out. It is owing to this sulphureous principle that linen, after it has been washed with soap, and is pretty well advanced in whiteness, is apt to be discoloured by lye which is brought to boil: for, by boiling, the sulphureous part is extracted from these ashes, and the lye becomes of a deep brown colour. Daily practice, then, shows the disadvantage of this sulphureous principle. Besides, as sulphur unites itself quickly and firmly with alkaline salts, it must weaken or altogether destroy a great quantity of these in the Marcott and Cashub ashes, and so render them of no effect in bleaching. These two reasons seem to me sufficient to exclude them from the bleachfield; especially as, by increasing the other materials, we can attain perhaps more speedily the same end.

"However, as custom has introduced them into general practice, we shall consider how they are to be manufactured. Dr Mitchell has, in a very ingenious and useful paper, contained in the Philosophical Transactions for the year 1748, delivered an account transmitted to him by Dr Linnaeus of the method of making potashes in Sweden. This account was contained in an academical dissertation of one Lundmark upon this subject at Aboe in Sweden. The substance of this account is, 'That birch or alder is burnt by a slow fire to ashes, and made into a paste with water. This paste is plastered over a row of green pine or fir logs. Above that is laid transversely another row of the same; and that likewise is plastered over. In this way they continue building and plastering till the pile be of a considerable height. This pile is set on fire; and whenever the ashes begin to run, it is overturned, and the melted ashes are beat with flexible sticks, so that the ashes incrust the logs of wood, and become as hard as stone.' This, in the Doctor's opinion, is the method of making the potashes that come from Sweden, Russia, and Dantzic: and that there is no other difference betwixt the ashes made in those different countries, but that the Russian, containing more salt, must be made into a paste with a strong lye.

"There would appear, by my experiments, a greater difference than this betwixt the Swedish ashes, if that is the true process, and those I have examined. I had discovered the greatest part of the Muscovy ashes to be lime. I suspected it might enter into the composition of the Marcott and Cashub; and have accordingly discovered it there. Without the same grounds, none would ever have searched for it. Whence then comes this lime? It must either enter into its composition, or arise from the materials managed according to the process directed.

"I have tried the birch ashes made into a paste with water. I have tried common charcoal made into a paste with a third part of potashes, and kept them in a strong reverberatory heat for some hours, and yet no such caustic substance appeared. I have kept earth and salts of kelp-ashes fused together for 24 hours in the furnace of a glasshouse, where the heat was just below the degree of vitrification; and yet no remarkable causticity appeared afterwards in the concreted mass. But supposing that there did, will ever this account for the generation of lime? These chemists do not assert that it is a calcareous causticity. The earth of vegetables kept in fusion with their salts, is so far from turning into a quicklime, that the mass takes the opposite course, and becomes glass. Bodies that, by the laws of nature, are vitrescible, can never, so far as we know, become calcareous. In one or other of these two substances all bodies terminate that are changeable by fire; and vegetables are of the former kind. Here it may be asked, Why then, since they endure such a fire, are they not vitrified? the objection would be just, did they contain nothing else but what was found in vegetables. But if we once allow that lime is one of the materials, the difficulty is easily solved: for lime, we know, in proportion as it is mixed, hinders the vitrification of all bodies. In effect, the earthy part in these ashes is almost vitrified: and I think that I have carried the vitrification yet farther in that part; but I never was able, with the utmost heat of a reverberatory furnace, continued for six hours, to produce any thing like a thorough vitrification in these ashes. The heat of the fire used in the process would seem to be very great; and must, if it were not very difficult, reduce them to glass. The invitrifiable nature of these salts, so far from being an objection, becomes a strong proof of my opinion.

"These salts have a remarkable pungency. This we have already seen is the natural effect of quicklime on salts.

"These salts are found to be the fittest for making soap, and to incorporate soonest and best with oils. Salts, we know, of themselves do not readily unite with oil; but when once mixed with quicklime, they have a greater tendency to union.

"Again, I find that these ashes are more easily fluxed than charcoal made into a paste with the third part salt; which is much more than the ashes contain. Now, it is observed that quicklime increases the fluxing power of alkaline salts; for the common caustic made of quicklime and alkaline salts is sooner fused than the latter alone.

"From these reasons, and the experiments that discover lime in these ashes, I am led to think, that it is not generated by the process, but mixed with the ashes when they are made into a paste. The following experiment is a convincing proof of what I have been endeavouring to make out.

"I boiled some pease-straw in a strong lye of pearl-ashes burnt into a black coal, and made it into a paste with water. Another quantity of straw was boiled in a lye made of one part of quicklime and four parts of pearl salts, the lye being poured off turbid from the lime. This straw was likewise burnt when dry, and made into a paste. These two substances were put in-

¹² Potash. to separate crucibles, and fused in a reverberatory furnace. The latter appeared to resemble the Marcott and Cashub ashes more than the former, which seemed to want their pungency."

Potashes and Pearl-ashes obtained from neutral salts. Though the only method of preparing the alkaline salt originally is by the combustion of vegetables, yet there are some neutral salts from which if it were possible to expel the acid, we should have it in our power to procure the finest pearl-ashes in vast quantity. These are vitriolated tartar, nitre, but especially sea-salt, on account of the inexhaustible quantities of it to be met with in the waters of the ocean. Unhappily, however, there are some objections to every one of those. The vitriolated tartar, or any other salt in which the vitriolic acid enters, cannot be decomposed without converting the acid into sulphur by charcoal-dust; in which case it is as difficult to get free of the sulphur as of the acid; and if we attempt it by frequent solutions in water, we destroy the phlogiston of the sulphur, and have only vitriolated tartar again instead of alkali. See CHEMISTRY, n^o 716, &c.

With respect to nitre, though its acid may be expelled by fire, yet it is too high-priced, and too much used in other manufactures, to be thought of for this purpose. A potash manufacture from sea-salt has indeed been lately erected in England. The principle on which this was established is, that the acid of sea-salt may be extracted by means of lime; and accordingly we find that the saline efflorescence, which frequently appears on walls, consists chiefly of the marine alkali deprived of its acid. But this, though delivered on the credit of a very eminent chemist, we can affirm from our own observation to be a mistake. Of the many cases in which we have examined this efflorescence, only one was found to be alkaline; the others uniformly appeared to be true Glauber's salt composed of the vitriolic acid and fossil alkali. Neither did this appear to be formed by any decomposition of salt originally in the plaster, but to be a real generation of both acid and alkali where none of them existed before. See EFFLORESCENCE.

POTATO, in botany. See SOLANUM.

¹ How potatoes were introduced into Britain. Potatoes, it is generally thought, came originally from North America, where they were not reckoned good for food. They were first (we are told) introduced into Ireland in the year 1565, and from thence into England by a vessel wrecked on the western coast, called *North Meols*, in Lancashire, a place and soil even now famous for producing this vegetable in great perfection. It was 40 years after their introduction, however, before they were much cultivated about London; and then they were considered as rarities, without any conception of the utility that might arise from bringing them into common use. At this time they were distinguished from the Spanish by the name of *Virginia potatoes*, or *battatas*, which is the Indian name of the Spanish fort. At a meeting of the Royal Society, March 18th, 1662-3, a letter was read from Mr Buckland, a Somerset gentleman, recommending the planting of potatoes in all parts of the kingdom to prevent famine. This was referred to a committee; and, in consequence of their report, Mr Buckland had the thanks of the Society, such members as had lands were intreated to plant them, and Mr Evelyn was desired to mention the proposals at the close of his Sylva.

* See Convolulus, n^o 5.

In Sweden, notwithstanding the indefatigable industry of Linnæus, the culture of potatoes was only introduced in 1764, when a royal edict was published to encourage their general cultivation. They were known there, however, at an earlier period; for in the *Memoirs of the Royal Academy of Sciences in Sweden*, 1747, M. Charles Skytse proposed to distil brandy from them, in order to save corn, which in that country is very dear. He found by experience, that an acre of land set with potatoes will yield a much greater quantity of brandy than when sown with barley.

The utility of potatoes to the common people is well known, and this utility has brought them into general use, and has extended them over every part of this kingdom. To promote this utility, and to make their cultivation more easy, a variety of experiments and inquiries have been made. Some of these we shall now lay before our readers, without repeating, however, what has been said on the same subject in the article AGRICULTURE, n^o 158-167. By many people the Irish purple potato is thought to be the sweetest and best; and of these the bright and middle-sized are directed to be set whole, in February, March, and April, in a fine deep tith, in any soil. During the frost, the first setting should be covered with litter or fern. They should be set six inches deep, and a yard distant from each other every way, in a kind of hillocks like a mole-cast; and they must be moulded every month or fortnight, as high as possible. By July or August, under each hillock there will be nearly a bushel of potatoes. The white kidney potato runs all into stringy roots in loose ground, while the pink-coloured will do extremely well in the way we have now directed; and the smallest of them, though often given to hogs, unless they be otherwise improper or unhealthy, will be very good feed.

The following experiments concerning the culture of potatoes are related in the Georgical Essays.

"By all the experiments that have been made, the Howard or large Bedfordshire potato is found to produce the largest crop. On that account they are chiefly used in feeding of cattle. In two beds, four feet wide, and 200 feet long, I planted in a common field a sufficient number of sets of this kind of potato, and managed them by a horse-hoe. The produce was 64 bushels, each bushel up-heaped, weighing about 70 lb. My cattle eat them boiled with as much eagerness as the best forts, and came on as well with them. I have built a boiling-house, &c. on Mr Young's plan, and during this whole winter have boiled potatoes for my cattle. For the fattening ones, I mix ground oats with them; and for the milk-cows, malt-dust; and dare venture to affirm, that they are much more profitable than either turnips or cabbages. Once, when my potatoes grew low, I desisted giving them to the milking-cows. Immediately, though fed with the best hay, they fell off amazingly in their milk. I therefore began again; and in a week's time they gave better than one-third more butter. I own this accidental discovery gave me much satisfaction, as it confirmed my opinion, that potatoes boiled are an excellent winter food for cattle. Their culture is not so difficult, at least not so precarious, as either turnips or cabbages. Their value is superior, and there is no risk of their giving a disagreeable taste either to butter or milk."

Potato.
6
Of the in-
crease of
potatoes.

milk. Add to this the vast increase of the Howard potato, and its equality with the best sorts when used for cattle.

"My gardener cut a large potato into nine pieces, which he planted with dung, in a drill, in the garden. By earthing up and laying the shoots, he produced 575 (A) sizeable potatoes, which weighed eight stone eight pound. Another of my servants produced, in the field, seven stone of good potatoes from the same number of sets. Though this experiment cannot always be executed in its full force in an extensive scale, it ought, notwithstanding, to be imitated as nearly as circumstances will allow. It shows, in the most distinguishing manner, the use of clean and careful husbandry.

"On the 14th of April, I cut a large white potato into 17 sets, which were planted in as many hillocks, at the distance of four feet. In the course of growing, the plants were earthed up, and on the 14th of October the crop was taken up: The produce, 10 pecks of sizeable potatoes. At the time that this experiment was made, I had several hillocks, in which I put three and four sets of the same kind of potato. But, upon the most careful examination, I could not observe that these hillocks produced a greater crop than the others planted with a single set. Hence it is obvious, that the potato spreads its roots most kindly when least crowded."

Whilst speaking of the increase of potatoes, we cannot help taking notice of a memoir by John Howard, Esq; of Cardington, in Bedfordshire, on a new kind of potato remarkable for its prolificacy. "In the year 1765 (says he) being at Clifton, near Bristol, I was informed a person had brought from America a new sort of potato, and with some trouble I procured half a dozen roots of it, as the greatest part of those brought over were already planted. That autumn I planted three of them, and in the following spring the other three, in my garden at Cardington in Bedfordshire; setting them in hillocks about six feet asunder. The strength of the stems, and largeness of the blossom and apples, gave the pleasing prospect of great increase: and accordingly, when I took them up in the autumn 1766, I found they had increased far beyond any of the common sort, which for some years I had encouraged our cottagers to cultivate. The produce from each cutting was in weight from 26 to 27 pounds and a half. I sent for two of the Bedford gardeners, who serve the market, to see them taken up, and they were surprised at the great increase. I gave some of them to these gardeners, and others to almost all our own cottagers. The increase continued to appear the same in the succeeding year, viz. 1767, as in the last: only, as many of the single potatoes had been then found to weigh four or five pounds each, I had now planted most of them in drills three feet asunder, in order to procure a greater number, and a less size. Their produce was now from 22 to 30 pounds from each cutting; and the potatoes were more

sizeable for common use. The vegetation was not so luxuriant as in those I before planted in hillocks; but the increase of these was, allowing the cuttings to weigh one ounce, full 400-fold. Having last year upwards of a waggon-load of these potatoes, I with pleasure ordered it to be made publicly known, that every person who chose to cultivate them were welcome to have a quantity for planting. In consequence of this, numbers applied in our own and the adjacent counties. In my plantations, as well as those of other persons, the increase has been still greater this year: for the season having proved very favourable, I have had from some hillocks 41 pounds and a half, allowing for dirt."

We now continue our extracts from the Geographical Essays.

"Take a bunch of the apples of any sort of potato. On raising Hang it up in a warm room during the winter, and in seed ing February separate the seeds from the pulp, by washing potatoes. the apples in water, and pressing them with the fingers. Then dry the seeds upon paper. In the month of April, sow these seeds, in drills, in a bed of earth well dug, and manured with rotten dung. When the plants are about an inch high, draw a little earth up to them with a hoe, in order to lengthen their main roots. When they are about three inches high, dig them up with a spade, and separate them carefully from each other, in order for planting out in the following manner. Prepare a piece of fresh ground by trenching it well. Dig up the seedling plants as before directed; and plant them out in the ground, thus prepared, in such a manner that there shall be 16 inches between each plant. As they advance in growth, let them receive one or two earthings up, in order to lengthen the main root, and encourage the shoots under ground. By this management, the potatoes will, in the course of one season, arrive at the size of hen's eggs, and the haulm will be as vigorous as if sets had been planted. But what proves the luxuriance in the most convincing manner, is, that flowers and apples are produced.

"In Lancashire, where the gardeners raise potatoes from seed, they are always two, and sometimes three, years in bringing them to full size. By the above method of transplanting, with wide distances, many of the potatoes nearly attain their full size in one season. It is observable, that these seedlings produce potatoes of all the different kinds; and sometimes new sorts are procured. We do not find any difference whether the apple comes from one kind or another. It is not so when we use the set, which invariably produces the same kind. Potatoes, when propagated from sets, after a number of years, are found to decrease in bearing; for which reason they should be brought back every 14 years to their original. From a want of attention to this circumstance, I have known potatoes so run out, that they hardly returned treble seed. The farmer complains that his land is tired of them; but the true cause

(A) Instances of the amazing increase of potatoes are very numerous, and are almost every year detailed in the public papers. In the Gentleman's Magazine for 1757, p. 480, we are told, that from one slice of a potato, set in the spring of the same year by Mr Simon M'Hoy, a farmer at Park near Tuam in Ireland, there proceeded no less than 84 stalks, which produced 965 potatoes.

⁷ **Potato.** cause is the age of the sets. The increase of potatoes raised from seed is astonishing. They continue in vigour for about 14 years; after which the produce gradually declines.

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On raising
early pota-
toes.

"As the culture of potatoes, and particularly of the early sorts for the table, has of late become an object of very general attention, I hope the following account of a new method of obtaining these (without the help of hot-beds) will be acceptable to the public.

"On the 2d of January 1772, I made a hot-bed for the forward sort of potatoes, and on the 7th put in the sets, placing a glass and frame over them, and taking every precaution to defend them from the frost. Of these small potatoes, or sets, there remained about 40 in a basket, which was accidentally hung up in a warm kitchen, and there remained unnoticed till about the 25th of April. I then accidentally observed the basket, and perceiving something green on the edge of it, took it down, and, to my great surprise, found that the potatoes had sprouted half a yard in length, and that there were a great number of very small potatoes formed on the fibrous roots which had grown out. I took them into my garden, and planted them in a rich sandy soil, without any manure. The roots I put into the ground three inches deep, and laid down the stems that had sprouted, horizontally, and covered them with two inches of soil, but left the tops uncovered. Without farther attention they grew surprisingly.

"On the 26th of May, I took up the roots planted in the hot-bed on the 7th of January. They by no means answered my expectations, or paid for the trouble of their culture: but, at the same time, I was astonished to find the others, which were put into the ground so late, to have produced larger potatoes than the roots in the hot-bed. I took up all the roots, and picked off the large potatoes from them, which amounted to from 4 to 12 on each root, and then set the roots again in the same ground. This, indeed, I have successfully practised for many years, sometimes even twice, and have had a third good crop at Michaelmas. When this method is tried, the roots must be watered on the evenings of hot days.

"In January 1773, in order to make a second trial of this experiment with a large quantity, I placed a great many potatoes of the early sorts on a thick layer of gravelly soil, close to each other, over an oven, slated over, but open to the south-west, and covered them two inches deep with the same earth. At the end of April I took them up, and found the stems about a foot long or more. For fear of injuring the fine and delicate fibres of the roots, I took great care in taking them up, and planting them in the soil. This I now manured, but in all other respects treated them in the manner above described, many of the fibrous roots having then potatoes formed upon them nearly as large as walnuts. For a week, the plants came on surprisingly, when, by one sharp night's uncommon frost, they were nearly destroyed. However, notwithstanding this, fresh stems grew up in a few days, and I actually gathered from them, on the 3d of June following, finer potatoes than were sold at that time, at Manchester, from 1s. to 1s. 6d. per pound, being the produce of hot-beds. After taking off the larger potatoes, I again planted

the roots for a second crop, and in September obtained a very large produce. I weighed the increase of many separate roots, which amounted from four pound eight ounces to 14 pound 12 ounces, the potatoes being the largest of the forward kinds I ever saw.

"Make a compost of earth, sand, and coal-ashes. With this mixture fill a tub about 16 inches deep. Plant this artificial soil with some sets of the early round potato, and place the tub in a stable opposite to a window, taking care to water the earth now and then. In all seasons the sets will sprout, and give a tolerable increase of potatoes. Last November I planted some sets in the above manner; and in February following I took up a considerable number of young potatoes, clean skinned and well flavoured.

"On the 18th of May 1772, finding some beds I had sown very early with onions, to be a missing crop, I was induced to make the following experiment. The year before, I had set some potatoes in another part of my garden in the common way; and as it is impossible but some will remain in the ground all winter, so I found a number of sprouts about three inches high, which I nipped off close to the ground, and transplanted them into the onion-beds, without any further preparation, about a foot and a half asunder, in the same manner that cabbages and cauliflowers are planted. As the season became immediately very dry, I was obliged to give my plants a little water for four or five successive nights; after which they began to flourish, and had the appearance of a promising crop during all the summer. At the usual time, in October, I ordered them to be taken up; and for size, quantity, and quality, they exceeded all I ever had in the common way. Had the ground been fresh, properly manured and prepared, and the plants put down at a proper distance from each other, I am of opinion that the success would have been still greater.

"From an accurate experiment made last year, I dare venture to recommend baked potatoes as an excellent food for hogs. The pork produced by this food was equal to that from barley and beans: but at present I cannot exactly ascertain the comparative experiment with regard to expence; however, I am of opinion, that roasted potatoes, considering the improvement of the hogs, is as cheap a food, if not cheaper, than can be given them. I roasted my potatoes upon a kiln, similar to what is used by oatmeal shellers for drying their oats. The difference in expence between boiling and roasting the potatoes is prodigious, both with regard to the labour and fuel. A kiln that will cost 3l. will roast potatoes sufficient for the maintenance of more than 20 hogs; and one man will bestow all the necessary attendance upon them, and do other work besides. The action of the fire, by dissipating the crude juices that are contained in raw potatoes, reduces them into a state highly wholesome and nutritious. Boiling does this in part, but not so effectually. A potato roasted in the manner above described, partakes much of the nature of a chestnut, and perhaps is not greatly inferior to it."

Potatoes are found to be useful food for most other animals. See AGRICULTURE, n^o 45.

To these experiments we shall add some important observations of Dr Anderson of Cotehead near Leith,

Potato.
12
Remarks
on the
seeds most
proper to
be planted.

who has paid a very particular attention to this as well as other branches of agriculture. Our readers will find the Doctor's remarks and experiments at large in the *Bath Papers*, volume fourth. He first considers the nature of the seeds most proper to be planted; and from his experiments he thinks it appears that the produce is not materially affected, by planting for seed, either whole potatoes or cuttings, or large or small potatoes as such; for it is only incidentally that these things can affect the crop. In the fifth volume of the *Bath Papers*, Mr Wimpey relates an experiment, by which it would appear that there is an advantage in planting cut potatoes. His conclusion is as follows. "The measure of all the ground planted, says he, was 325 poles; the whole produce 378 bushels. The measure of the ground planted with cut potatoes was 265 poles; the produce 312 bushels. The ground planted with whole or uncut sets was 60 poles, and the produce of the same 66 bushels. Now, if 48 bushels, the whole quantity of sets used, produced 378 bushels, then 34 bushels, the quantity cut, should produce 267 bushels; but they produced 312, which is 45 bushels more than the proportion. Again, if 48 bushels produced 378 bushels, then 14 bushels should have produced 110 bushels; but 14 bushels of uncut produced only 66 bushels, which is 44 bushels less than the proportion. A preference of 40 per cent. in favour of cut potatoes, in comparison with whole sets." Mr Wimpey corroborates the fact in the sixth volume of the same work, and informs us, moreover, that he used to supply many of his neighbours with potatoes for planting; some of whom desired to have them all small, as they had found them equally productive with the larger, and saved much trouble in cutting. "Others (continues he) preferred the largest, who carried their economy much further: they, it seems, used to pare them, eat the fleshy part, and plant the rinds only. Upon inquiry, I found it was not an unusual practice among the cottagers; and I have been credibly informed they get as large crops and as good potatoes in that method of planting as in any other whatever. If this be a fact, it seems to appear that the fleshy part of the bulb is of no use in supplying nourishment to the young fruit after the fibrous roots have put forth and laid hold of the ground. Perhaps an experiment of this sort may be thought worth making." The weight of the crop, however, Dr Anderson asserts (and Mr Wimpey agrees with him, see *Bath Papers*, vol. v. p. 34.), is always in some measure influenced by the weight of the seeds planted; but the weight of produce is not augmented in the same proportion with the weight of the seed planted; the smallest seed yielding the greatest returns in proportion to the seed, but the smallest in proportion to the extent of ground. It is in no case profitable, however, the Doctor thinks to plant small potatoes (B), or small cuttings, unless where it is meant to increase

as fast as possible a favourite kind; in which case it may be sometimes eligible to plant pieces very small, as in that way the kind will be most quickly multiplied. We may also remark here, that such as wish for a large increase should never plant the worst of the crop; it is, we know, extremely common, and may indeed be an immediate saving; but it is unquestionably a loss upon the whole; and perhaps it is one cause of the *curl disease*, which is the sure indication of a poor dwindling crop, and of which we shall speak more at large immediately.

Our author further remarks, that there seems to be no reason to suspect that eyes taken from any particular part of the bulb are possessed of a degree of prolificacy greater than those taken from any other part of it, independent of the size of the fleshy part that adheres to the eye. It is however highly probable that a difference in the crop, either with respect to the number and size, or general weight of the whole, would result from planting large cuttings of equal weight, taken from the big end of large potatoes, or from the point, as many eyes would be in the last in comparison of the first. This is therefore one of the many preparatory experiments that require to be made. It is possible too that even the apples may be an object of value, and may indicate a thriving crop or otherwise; but of this there is no certainty, as no specific experiments have yet been made on this subject.

With respect to the effects of cutting the stems of potatoes while growing, the Doctor seems to be doubtful. The stems of potatoes, if cut while growing, and used green, are found to be a wholesome food for cattle and horses. But though some farmers maintain that the produce in potatoes is not lessened by having the stems cut off while they are in a state of vigorous vegetation; others as positively insist that the crop is essentially injured by that operation. It is proper that this point should be ascertained. Probably the crop is hurt if the stems are cut over before they have attained a certain point of maturity, though it is possible they may be afterwards cut without doing any essential injury to it.

We have already mentioned that an experiment was made a good while ago in Sweden, to extract ardent spirits from potatoes. Other experiments have been made in this country of a later date, but with little effect. This, however, appears to have proceeded either from ignorance or a want of proper attention to the fermentation and after distillation; as appears from Dr Anderson's experiment, which succeeded extremely well by attending to these processes. What he made he asserts to have been the finest and most agreeable vinous spirit he ever saw, resembling in taste very fine brandy, but more mild, and having a certain coolness on the stomach peculiar to itself.

Much may be done in bringing potatoes to perfection

(B) In opposition to this, it is the opinion of even practical men, that the small potatoes are to be preferred: "I have been informed (says Mr Hollins) by a native of America, that what we call the long red American potato, grows in that rich and newly-cleared soil to a very large size; but that the potatoes proceeding from the roots were never used as seed; for there sprung from the stalk, very near the surface of the ground, small potatoes as they called them; but, he said, they were about the size of those raised in England, and those were always planted. I hope the Society will forgive my mentioning this, as it confirms what I have already said, 'that small potatoes are best for seed.'" *London Society of Arts*, vol. xi. p. 82.

Potato.

13
On cutting
the stems
of potatoes
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spirits from
potatoes.

Potato.
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On attend-
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veral varie-
ties of po-
tatoes.

tion by attending to their several varieties. For this purpose some particular potato must be fixed upon as a standard; and when this is done, the inquiry must be carried on by attending, *first*, to their appearances below ground, as, 1. the general form and size of the bulbs; 2. their colour; 3. the smoothness or roughness of the skin; 4. the consistence, that is, the mealiness or viscosity and taste of the bulb; 5. the colour, length, thickness, &c. of the umbilical cord; 6. their tendency to go deep, or to rise near the surface; to ramble wide, or to adhere close to the stem; 7. the time when the bulbs knot and set; marking, not by the kalendar only, but also compared with the advance of the plant above ground; 8. the time when they attain perfect maturity with respect to size, and also that period of their growth at which they lose the herbaceous, and attain the farinaceous, taste; 9. their general prolificacy; 10. how long they may be kept, at what season they are in greatest perfection for eating; &c. We must *next* attend to the particulars observable above-ground; as, 1. the general height, colour, and form of the stem; 2. their tendency to push out many or few stems from a root; 3. whether they carry blossom or not; 4. the form, dimensions, and colour of the leaves; 5. the form, colour, and general habitude of the blossom where there is any; 6. the time at which the blossom appears; 7. the tendency they have to produce few or many apples; 8. the tendency they have to produce those excrescences on the stalks that resemble potatoes below ground, which may be called air potatoes; 9. the comparative hardness or tenderness of the leaves, in respect of frost or other variations of weather that affect them. And, *lastly*, we must attend to the particulars that concern the whole plant; as, 1. the soil which seems best to suit each kind; 2. the mode of culture that best agrees with them; 3. the accidents which are most liable to affect them; and in general every particular that could indicate any difference between one kind and another.

16
Opinions
on raising
seedling po-
tatoes.

Our author next considers the circumstances of raising seedling potatoes. His mode of raising them was similar to that recommended in the *Georgical Essays* quoted above; but he differs with respect to the utility or success of that mode. It has been alleged, he says, that potatoes, which have been long propagated by means of bulbs, lose in time their generative quality, so as to become much less prolific than at first; and it is asserted that those bulbs which have been lately obtained from seeds are much more prolific, and consequently much more profitable for being employed as plants than others: but this opinion appears to have been adopted without sufficient examination: for there appears not the smallest indication of superior prolificacy in those raised from seeds, but rather the reverse. That potatoes do not degenerate in point of prolificacy in consequence of being long propagated in the usual way, seems to be confirmed by the general experience of all Europe. It is now about a hundred years since the potato was pretty generally cultivated in Ireland, and it has been very universally cultivated in Britain for

Potato.
50 years past; and all that have been reared in it since their first introduction two hundred years ago, a very few of late only excepted, have been propagated from bulbs only; so that if they had declined in point of prolificacy, the degeneracy should in this time have been very apparent. Nothing of that kind however was ever remarked, nor any insinuation of that sort thrown out, till the discovery of rearing potatoes from seed was made, when it was for the first time heard of. There are many persons now living who have been in the constant practice of rearing potatoes for 30 or 40 years; and notwithstanding the general tendency that mankind have to dispraise the present, when compared to past times, yet none of them have given the smallest hint of degeneracy in this respect. And perhaps it will be found that this is merely a groundless notion, that has originated from the partial fondness of those who first propagated this plant from seed, in favour of their new discovery. It has been further said, that by raising potatoes from seed, many new and valuable kinds may be obtained; and it is also asserted in the *Georgical Essays*. Indeed an opinion of obtaining new varieties of plants by propagating them from seed universally prevails among naturalists. But Dr Anderson, in his first paper, doubts whether this be fact, and whether, when any of these occur, they have not been the effect of accidental position or other causes. We may certainly (says he) assert on the whole, that if the practice of rearing potatoes from seeds shall ever be productive of any advantages to society, they have not yet been discovered. Since he wrote that treatise which appears in the *Bath Papers*, vol. iv. (and of which we are now giving a short account), however, he has had occasion to alter his opinion, which he does with great candour in vol. v. The experiment which induced him to alter his opinion, and which appears to be decisive, was made with the seed of a potato procured from Ireland of a very peculiar kind. Its colour was a dirty dark purple, its shape a round irregular bulb, and its stem tall and upright. The seeds procured from this potato were sown by themselves, and the seedlings when of a proper size were transplanted. From the appearance of the stems he soon discovered that they were not all of one sort, and on taking them up the variety was almost infinite; and such as could not be accounted for on the principles of a mongrel adulteration. The diversities respected colour, shape, &c. some of which he enumerates. See *Bath Papers*, vol. v. p. 127.; see also p. 35. where Mr Wimpey controverts the Doctor's former opinion.

17
On the
curled dis-
ease.
Respecting the causes and prevention of the *curled disease* in potatoes there has been a great variety of opinions, which we have detailed at some length under the article AGRICULTURE, p. 267 to 270. Dr Anderson confesses that he can say but little *positive* as to the cause of this disorder, but he thinks a good deal may be said on the *negative* side of the question. It was little known till lately (c), and in the northern parts of this island it was absolutely unknown but a very few years ago; and even now in the more remote corners it is still less frequent than in the more southern and

(c) In the eighth volume of the Transactions of the London Society for Encouragement of Arts, &c. p. 43. we are told that the curl first appeared in 1764, in the very district in Lancashire where they were first cultivated.

Potato.

and more commercial districts of the island. It has been supposed that nature, fated as it were by having long produced this plant in a climate not deemed congenial to it, had become so far exhausted as to occasion this disease. But in this case, the more northern parts, where the climate is most unfavourable, should have been soonest affected. It has been also thought that potatoes, whose bulbs are frost-bitten before they are housed, occasion this disease in the plants they produce. But the fact is, that they are least liable to the disease in those districts where they are most exposed to frost. A potato can never indeed be benefited by frost; but it is not at all probable that the being touched by it occasions the curl. The taking up potatoes before they arrive at maturity has been thought to occasion the disease; but in places where they must be taken up so, the disease is scarcely known. It has also been thought that potatoes obtained from seed are entirely free from it. But Dr Anderson gives a proof of the contrary; for one half of the plants of a large field planted from potatoes the third year from the seed were curled; while another field adjoining raised from potatoes that never were, that he knows, produced from seed in this country, had scarcely one curled plant in the whole. The disease has been supposed by others to arise from the soil or season. But that this is not the case, appears from the circumstance of a single field which Dr Anderson planted with potatoes of the very same sort, but obtained from different persons. The ridges were intermixed, and the one was very much curled, and the other perfectly free. The disease, therefore, appears to arise from infected seed: it is however possible that it may be communicated by juxtaposition; and if so, the disease might be in a great measure if not entirely avoided, by pulling out those that showed the least symptom of it, on their first appearing above ground.

In the Transactions of the London Society for encouragement of arts, &c. we find a good deal about the curl disease. Many of the writers agree in opinion with Dr Anderson in many particulars; and particularly, that though the disease may be prevented, we do not yet know enough of its nature to be able to cure it. See their vol. viii. p. 18, &c. ix. p. 52, &c. and x. p. 75. In this last volume we are told that the principal causes of the curl are three: 1. From their being forced by cultivation to overgrow their power for vegetation; 2. From their vegetative power being dried up in ebb soil by the scorching heat of the sun; and, 3. From their being exposed too long after they are cut in sets before they are planted.

18
On the soil
and season
most pro-
per for po-
tatoes.

It is generally and very naturally believed that a dry soil or a dry season necessarily produces the driest potatoes. But there is good reason to doubt the truth of the opinion. The year 1775 was the driest and warmest season that has been known in Scotland within the memory of man, yet the potatoes of that year's crop were watery almost to a proverb: on the other hand, the potatoes of crop 1777, although it was a remarkably rainy season, were as dry and mealy at least

as is common, and much more so than in the year 1775. It deserves also to be remarked, that the crop of 1775 was almost double in quantity to that of 1777. Hence a dry season would seem to augment the produce, though it does not for certain in all cases improve the quality, of this crop: nor does a dry soil necessarily insure mealy potatoes; for our author says he has often seen potatoes of the same kind, and of the same year's produce, reared in two different places; the one of them in a naturally damp soil, which turned out to be much freer and more mealy than the others which were reared on a drier and sharper soil. He confesses, that he has also often seen it turn out in fact, that potatoes raised in those districts where the soil is hot and sandy, are usually more free and tender than those raised in countries where the soil is cold and damp. Our author tries to account for these contradictory phenomena by conjecturing the probable cause of the wateryness or dryness of a crop. He asks, Whether in this respect the crop is anywise affected by the degree of ripeness that the plants employed for seed may have attained in the preceding season? That this is the case he thinks highly probable. Potatoes which, on account of the richness or other peculiarity of the soil, continue in a state of vegetation highly luxuriant till they are nipped by frost, or checked in their growth by other inclemencies of the season, have much less chance of being dry and mealy than others of the same sort which have attained their full growth before the coldness or inclemency of the weather checked them. But our author's question does not relate to this, but to the effect these unripe potatoes, used as seed, would have on the succeeding crop; a circumstance which experience alone can determine. "But even if it should be found (continues our author) that the maturity of the seeds affected the quality of the potatoes, it would not follow invariably that the seeds produced on early dry soils would be better than those from later soils; because it might sometimes happen from local position, and other accidental circumstances, that the growth of the potatoes in the dry early soil might be checked by frosts many weeks before those on the other soil were affected, in consequence of which the plants in the cold soil might attain to more perfect maturity than those on the drier one. I mention this peculiarity merely to show how cautious the farmer ought to be in adopting general conclusions without carefully attending to all the collateral circumstances that may affect his experiment. I shall only farther add on this head, that I had occasion to know well a dry warm spot of ground on which the stems of the potatoes of crop 1776 were frost-bitten at least *six weeks* before those on another spot at some miles distance from it, where the soil was naturally more cold and damp, were in the smallest degree affected by it. It likewise so happened, that the potatoes raised on the first-mentioned spot in the year 1777 (their own frost-bitten (D) seed was employed) had such a peculiar acrid and bitterish taste as to be hardly at all eatable, while those in the colder place of that crop had nothing of that unusual

Potato.

(D) Observe, the term *frost-bitten* is here applied to the stems only, and not to the bulbs. The stems were so much hurt by the frost as to turn black and decay, but the bulbs were taken up before the frost had been sufficiently intense to hurt them.

Potato.

usual taste. Whether this diversity was occasioned by the circumstance here alluded to, I do not take it on me to say. In matters of such nice disquisition as the present, many facts obtained by very accurate observation are necessary before any conclusion can be relied on."

Potatoes, when planted in water, shoot out a great number of fine white roots like threads into the water; but on none of them is there to be found the least appearance of a bulb; while on the other hand the potatoes in that case always grow on the top. Potatoes are found to be extremely useful in bringing exhausted land into heart again. See AGRICULTURE, n. 35 and 186, p. 309, col. 1. The bishop of Killaloe in Ireland directs the use of them for this purpose in a letter in the *Bath Papers*, vol. 4. p. 232, and confirms its utility in this respect by experiments of his own. In the 10th vol. of the *Transactions of the London Society for Encouragement of Arts, &c.* p. 34, there is also a most decisive proof of this utility.

We have been induced, from the extensive utility of this root, to extend our observations on the subject to a greater length than we should otherwise have done. Such of our readers as wish for further information, will of course consult the books from which we have made up the present article, as well as other books on Agriculture; in which they will find the observations and experiments which we have mentioned at much greater length than we could possibly give them. In the sixth volume of the *Bath Society Papers* there is an excellent paper on the culture of potatoes and feeding hogs with them during seven years by John Billingsley Esq; of which our limits do not permit us to take particular notice. There are also a variety of other papers in the several volumes of that work, as well as in the *Transactions of the London Society*, which we have already several times mentioned; which will deserve the particular attention of such as wish well to the poor, or have a desire still farther to extend the utility of this most valuable root. We have already mentioned a cheap preparation by means of potatoes for the poor, see AGRICULTURE, n. 161; and we shall finish the present article with a receipt to make a potato herrico, which may be equally useful to those whose circumstances are not such as to make them regardless of economy. We take it from the Gentleman's Magazine, and give it in the words of a person who had tried the experiment.

Scrape the skin clean off four pounds of good raw potatoes, then wash them clean in fair water: take two pounds of beef, one of mutton, and one of pork; or as you like best, four pounds of any of these meats; cut them into pieces of three or four ounces each, season them very well with pepper and salt and a good onion chopped very small: have ready a strong wide-mouthed stone-jar, such as hares are usually jugged in; slice thin a layer of the potatoes into the jar, then a layer of the seasoned meat over them, and so alternately layers of potatoes and meat; let your uppermost layer be potatoes, so that your jar be about three quarters full, but put no water into your jar; then close or stop the mouth of it with a large well-fitted piece of cork, covering the same with a strong piece of canvas, and tying it down with pack-thread, so as only a little of the steam may escape in the stewing; for a little should constantly evaporate from the side of the cork to save the jar from bursting. Then place your jar upright in a kettle of

VOL. XV. Part II.

cold water on the fire, so as the mouth of the jar may be always two inches above the water in the kettle when boiling. The herrico in the jar will begin to boil some minutes sooner than the water in the kettle, and that for obvious reasons. In about an hour after the water in the kettle begins to boil, your herrico will be fully stewed. Then take out and open the jar, pour out the herrico into a deep dish, and serve it up.

This excellent, wholesome, and economical dish supplies an agreeable dinner twice a week to a family consisting of three grown people, and three children under fourteen years of age, where neither health nor good stomachs are wanting, thanks to God: and, in point of economy we must observe, that here is the whole article of butter saved, as also the whole article of bread, or nearly so; nor does there require so large or so continued a fire, nor so much time or trouble as is necessary for the dressing of many other dishes that by no means deserve the preference to this excellent herrico.

We have also (by way of change) made it with powdered beef, sometimes with powdered pork, sometimes with half fresh beef or mutton and half pickled pork, and found it good in all these ways, particularly with three pounds of fresh beef and one of pickled pork. We have left off sending pies and stews to the bakers. We sometimes (in a larger kettle) boil a small piece of powdered beef along-side of the jar, by continuing the boiling an hour and an half longer, and this serves us to eat cold the next day, with hot garden-stuff or a pudding.

POTATO-Bread. See BREAD of Potatoes.

Spanish POTATO. See CONVULVULUS, n. 5.

POTENT, or POTENCE, in heraldry, a term for a kind of cross, whose ends all terminate like the head of a crutch. It is otherwise called the *Jerusalem cross*, and is represented Plate CCXXIX, fig. 12, 12.

POTENTIA (POWER), that whereby a thing is capable either of acting or being acted upon.

POTENTIAL, in the schools, is used to denote and distinguish a kind of qualities, which are supposed to exist in the body in *potentia* only; by which they are capable in some measure of affecting and impressing on us the ideas of such qualities, though not actually inherent in themselves; in which sense we say, potential heat, potential cold, &c.

POTENTIAL Caution, in medicine, denotes the consuming, or reducing to an eschar, any part of the human body by a caustic alkaline or metallic salt, &c. instead of a red-hot iron, which last is called the *actual cautery*.

POTENTIAL, in grammar, an epithet applied to one of the moods of verbs. The potential is the same in form with the subjunctive, and is, according to Ruddiman, implied in that mood, for which reason that grammarian rejects it; but others will have it to differ from the subjunctive in this, that it always implies in it either *possibility*, *voluntas*, or *debeo*. It is sometimes called the *permissive mood*, because it often implies a permission or concession to do a thing. See GRAMMAR.

POTENTILLA, SILVER-WEED, *wild tansey*, or *cinquefoil*: A genus of the pentagynia order, belonging to the icosandria class of plants; and in the natural method ranking under the 35th order, *Senticosia*. The calyx is decemfid; there are five petals; the seeds roundish, naked, and affixed to a small dry receptacle. The species are, 1. The fruticosa, or shrubby potentilla, com-

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Potato
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Potentilla.

Potentilla,
Poterium.

monly called *shrub-cinquefoil*. This rises with a short shrubby stem, dividing into a branchy full head, three or four feet high; closely garnished with pinnated leaves of five oblong, narrow, acute-pointed, folioles, pale green above, and whitish underneath; and the branches terminated by clusters of large, spreading, yellow flowers. This is a beautiful deciduous flowering shrub, worthy a place in every curious collection. It grows wild in Yorkshire and other northern parts of England, &c. but has been long cultivated in gardens as an ornamental shrub. 2. The reptans, or creeping common five-leaved potentilla, or five-leaved grass, hath a thick fibry root, slender, trailing, repent stalks, digitated, five-lobed, petioled leaves, and yellow flowers singly. 3. The rupestris, or mountain upright cinquefoil, hath upright stalks, eight or nine inches high; pinnated five and three-lobed alternate leaves, having oval crenated lobes, and the stalks terminated by small white flowers. 4. The recta, or erect seven-lobed yellow cinquefoil, hath erect stalks, seven-lobed leaves; having three lobes spear-shaped and ferrated, green and hairy on both sides, and the stalks terminated by corymbose clusters of yellow flowers. 5. The fragaroides, or strawberry-like trailing potentilla, hath a somewhat tuberous root, furnished with many long fibres, long trailing shoots, rooting at the joints; pinnated, mostly three-lobed leaves, having oval lobes, with the extreme lobe the largest, and clusters of small white flowers. This species bears a great resemblance to the small sterile strawberry plants. 6. The argentea, silvery upright potentilla, hath upright stalks, branching a foot high; and five-lobed leaves, having the lobes wedge-shaped, cut on the edges, hoary and white underneath, and the branches terminated by small yellow flowers.

All these plants flower in June and July; the flowers are composed each of five roundish petals, and about 20 stamina. They are all very hardy, and may be employed in the different compartments of the pleasure ground. Their propagation is very easy. The shrubby potentilla may be propagated abundantly by suckers, layers, and cuttings; all of which will readily grow, and make plants in one year, which after having two or three years growth in the nursery will be fit for any of the shrubby compartments. All the herbaceous kinds may be propagated by parting the roots in autumn or spring, or by seed in any of those seasons.

POTERIUM, GARDEN BURNET: A genus of the polyandria order, belonging to the monœcia class of plants; and in the natural method ranking under the 54th order, *Miscellanea*. The male calyx is tetraphyllous; the corolla quadripartite; and there are from 30 to 40 stamina. The female calyx is tetraphyllous; the corolla quadripartite; there are two pistils; the berry is formed of the indurated tube of the corolla. The species are, 1. The sanguiforba, or common garden burnet, hath fibry perennial roots, crowned by a large tuft of pinnated leaves, or six or seven pair of sawed lobes, terminated by an odd one; upright angular stalks, dividing, and branching a foot and a half high, terminated by oblong spikes of purplish red flowers. This species grows wild in England, in chalky soils; but has been long cultivated as a choice salad-herb for winter and spring use, it being of a warm nature; the young leaves are the useful parts. It is perennial in root, and retains its radical leaves all the year, but the stalks are

annual. 2. The hybridum, hybrid agrimony-leaved Montpellier burnet, rises with upright, taper, closely gathered stalks two feet high; pinnated odoriferous leaves of three or four pair of sawed lobes, terminated by an odd one; and the stalks terminated by long foot-stalks dividing into smaller, each supporting a small roundish spike of flowers. This species often proves biennial; but by cutting down some of the stalks before they flower, it will cause it to multiply at bottom, and become abiding. 3. Poterium spinosum, shrubby spinous burnet of Crete, hath a shrubby stem and branches, rising a yard high, armed with spines; small pinnated evergreen leaves, of six or seven pair of lobes, terminated by an odd one, and the branches terminated by small heads of greenish flowers.

All these species flower in June and July, succeeded by ripe seeds in Autumn. They are all naturally perennial; but the two herbaceous ones are abiding in root only; the other in root, stem, and branches: the two former are hardy, and the third requires shelter in winter. The first sort merits culture in every kitchen-garden for winter and spring salads. Some plants, both of the first and second sorts, may be introduced in the herbaceous collection in the pleasure-garden for variety. The third sort must be kept always in pots to have shelter in winter. They are all easily propagated, the first sort by seed and by parting the roots. The second sort may also be increased by seeds and slips off the root, as for the former sort. And the propagation of the third is by slips or cuttings of the branches in spring and summer, planted in pots, and placed under glasses, giving shade and water; or might be forwarded more by plunging them in a hot-bed.

Burnet is of a heating, drying nature, cordial and alexipharmac; in summer, the leaves are used for cool tankards, to give the wine an agreeable flavour. The powder of the root of the first species is commended against spitting of blood, bleeding at the nose, dysenteries, and diseases attended with violent secretions. In winter and spring, the young tender leaves are used in salads. For its uses as food for cattle, see *AGRICULTURE*, n° 184.

POTHOS, in botany; a genus of the polyandria order, belonging to the gynandria class of plants. The spathe or sheath is a simple spadix covered; there is no calyx, but four petals, and as many stamina; the berries dispermous.

POTION, a liquid medicine, consisting of as much as can be drunk at one draught.

POTIPHAR, or **PUTIPHAR**, an officer of the court of Pharaoh king of Egypt, and general of his troops, according to our translation, Le Clerc, and the version of the vulgate; but according to the Hebrew and Septuagint, the chief of his butchers or cooks. The Hebrew text, the Septuagint, and vulgate, call him Eunuch. But it is probable it in this place means only an officer of the king's court, for he was certainly married and had children. We have no other accounts of him but what appear in scripture; and that account is too generally known to require to be enlarged on in this place. See *Genesis xxxviii. xxxix. &c.*

POTOSI, a city of Peru in South America, situated at the bottom of a mountain of that name, in which is the richest silver mine ever discovered. To give an idea of its richness, we shall mention its produce at different

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Potsdam, ferent times. Exclusive of what was not registered, says Abbé Raynal, and was smuggled away, the fifth part belonging to the government, from 1545 to 1564, amounted to 36,450,000 livres * *per annum*. But this abundance of metals soon decreased. From 1564 to 1585, the annual fifth part amounted to no more than 15,187,489 livres four sols $\frac{1}{2}$. From 1585 to 1624, it amounted to 12,149,994 livres 12 sols $\frac{1}{2}$. From 1624 to 1633, to 6,074,997 livres six sols $\frac{1}{2}$. From this last period, the produce of these mines hath so evidently decreased, that in 1763 the fifth part, belonging to the king, did not exceed 1,364,682 livres 12 sols $\frac{1}{2}$. Situated in W. Long. 67. S. Lat. 22. See the article PERU, p. 220, col. 2.

POTSDAM, or POSTDAM, a town of Germany, in the circle of Upper Saxony, with a palace, belonging to the king of Prussia. It is seated in an island ten miles in circumference, formed by the rivers Sprae and Havel. The palace is very curious, and finely built upon a delightful spot 12 miles west of Berlin. E. Long. 13. 42. N. Lat. 52. 34. Reisbeck in his travels informs us, that the houses in Potsdam are still finer than those of Berlin; but like them they are inhabited only by persons of the lower and middling ranks.

POTT (Percival), was born in London in 1713. He received the first rudiments of his education at a private school at Darnce in Kent; and became an apprentice to Mr Nourse, one of the surgeons of St Bartholomew's hospital; of which hospital, in 1744-5, he was elected an assistant surgeon, and in 1749 appointed one of the principal surgeons. In 1746, he married the daughter of Robert Cruttenden, Esq. His first publication is said to have been planned in 1756, during his confinement in consequence of a compound fracture of the leg: from that time, his pen was seldom long unemployed. His practice and his reputation were now rapidly increasing: in 1764, he was elected a fellow of the Royal Society; and afterward was complimented with honorary diplomas from the Royal Colleges of Surgeons at Edinburgh and in Ireland. In 1787, he resigned the office of surgeon to St Bartholomew's hospital, "after having served it (as he used to say), man and boy, half a century;" and on the 22d of December 1788, after an illness of eight days, he expired.

"The labours of the greatest part of his life (says Mr Earle, who published his *Chirurgical works*), were without relaxation; an increasing family required his utmost exertion: of late years he had a villa at Neafden; and in the autumn usually passed a month at Bath, or at the sea-side. Thus, though he gathered, as he expressed it, some of the fruit of the garden which he had planted as he went along, and always lived in a generous and hospitable manner, at the same time bestowing on four sons and four daughters a liberal and necessarily expensive education, and applying large sums to their establishment during his lifetime, he left an ample provision for them at his decease. Among his papers was found, what he had often mentioned, a small box, containing a few pieces of money, being the whole which he ever received from the wreck of his father's fortune. With this was deposited an exact account of every individual fee which a long life of business had produced—abundant evidence of well spent time, and the industrious application of abi-

lities, to which the *res angusta domi*, at the commencement, probably acted more powerfully as an incentive than as an obstacle."

POTTER (Christopher), a learned English divine, was born in 1591, and bred at Oxford. In 1633, he published his "Answer to a late Popish Plot," intitled *Charity mistaken*, which he wrote by special order of King Charles I. whose chaplain he was. In 1634, he was promoted to the deanery of Worcester; and, in 1640, was constituted vice-chancellor of the university of Oxford, in the execution of which office he met with some trouble from the members of the long parliament. Upon breaking out of the civil wars, he sent all his plate to the king, declaring, "that he would rather, like Diogenes, drink in the hollow of his hand, than that his majesty should want;" and he afterwards suffered much for the royal cause. In consideration of this he was nominated to the deanery of Durham in 1646, but was prevented from being installed by his death, which happened about two months after. He was a person learned and religious, exemplary in his conversation, courteous in his carriage, of a sweet and obliging nature, and of a comely presence. He was remarkable in his charity to the poor.

POTTER (Dr John), archbishop of Canterbury, was the son of a linen-draper at Wakefield in Yorkshire, where he was born about the year 1674. He studied at University college, Oxford; and at 19 published *Variantes lectiones & notæ ad Plutarchi librum de audiendis poetis; & ad Basilii magni orationem ad juvenes, quomodo cum fructu legere possint Græcorum libros*, 8vo, 1693. In 1697, came out his edition of *Lycophron*, in folio; which is reckoned the best of that obscure writer: soon after, he published his *Antiquities of Greece*, 2 vols 8vo. These works established his literary reputation, and engaged him in a correspondence with Grævius and other learned foreigners. In 1706, he was made chaplain to the queen; in 1715, bishop of Oxford; and in 1737, he succeeded archbishop Wake in the see of Canterbury; which high station he supported with much dignity until his death in 1747. He was a learned and exemplary churchman; but not of an amiable disposition, being but too strongly tinctured with the pride of office; nor is it to his credit that he disinherited his eldest son for marrying below his rank in life. His "Theological works, containing sermons, charges, discourses on church-government, and divinity lectures," were printed at Oxford, in 3 vols, 8vo, 1753.

POTTERY, the manufacture of earthen-ware, or the art of making earthen vessels. See *DEFT-Ware*, *STONE-Ware*, and *PORCELAIN*, &c.

The wheel and lathe are the chief and almost the only instruments in pottery: the first for large works, and the last for small. The potter's wheel consists principally in the nut, which is a beam or axis, whose foot or pivot plays perpendicularly on a free-stone sole or bottom. From the four corners of this beam, which does not exceed two feet in height, arise four iron bars, called the *spokes of the wheel*; which forming diagonal lines with the beam, descend, and are fastened at bottom to the edges of a strong wooden circle, four feet in diameter, perfectly like the felloes of a coach-wheel, except that it has neither axis nor radii, and is only joined to the beam, which serves it as an axis by the iron-bars. The top of the nut is flat, of a circular

Pottery
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Poverty.

cular figure, and a foot in diameter: and on this is laid the clay which is to be turned and fashioned. The wheel thus disposed is encompassed with four sides of four different pieces of wood fastened on a wooden frame; the hind-piece, which is that on which the workman sits, is made a little inclining towards the wheel; on the fore-piece are placed the prepared earth; on the side-pieces he rests his feet, and these are made inclining to give him more or less room. Having prepared the earth, the potter lays a round piece of it on the circular head of the lathe, and sitting down turns the wheel with his feet till it has got the proper velocity; then, wetting his hands with water, he presses his fist or his fingers-ends into the middle of the lump, and thus forms the cavity of the vessel, continuing to widen it from the middle; and thus turning the inside into form with one hand, while he proportions the outside with the other, the wheel constantly turning all the while, and he wetting his hands from time to time. When the vessel is too thick, he uses a flat piece of iron, somewhat sharp on the edge, to pare off what is redundant; and when it is finished, it is taken off from the circular head by a wire passed under the vessel.

The potter's lathe is also a kind of wheel, but more simple and slight than the former: its three chief members are an iron beam or axis three feet and a half high, and two feet and a half diameter, placed horizontally at the top of the beam, and serving to form the vessel upon: and another larger wooden wheel, all of a piece, three inches thick, and two or three feet broad, fastened to the same beam at the bottom, and parallel to the horizon. The beam or axis turns by a pivot at the bottom in an iron stand. The workman gives the motion to the lathe with his feet, by pushing the great wheel alternately with each foot, still giving it a greater or lesser degree of motion as his work requires. They work with the lathe with the same instruments, and after the same manner, as with the wheel. The mouldings are formed by holding a piece of wood or iron cut in the form of the moulding to the vessel, while the wheel is turning round; but the feet and handles are made by themselves and set on with the hand; and if there be any sculpture in the work, it is usually done in wooden moulds, and stuck on piece by piece on the outside of the vessel. For the glazing of the work, see GLAZING.

POTTLE, an English measure containing two quarts.

POVERTY signifies indigence or want of riches, and has been the lot of a large portion of men in every age. Whether, on the whole, it has been productive of good or bad consequences, has been disputed. In a moral view, perhaps it has been, on the whole, useful, as adversity is in general more conducive to virtue than prosperity, which too often leads to luxury and vice.— Sometimes, however, poverty has had a baneful effect upon the mind, and has prompted men to commit very inhuman actions; but this in civilized communities very seldom occurs. In a political view, poverty is thought by some to be hurtful: Raynal thinks it is a check to population, (see his History, vol. vi. p. 471.); and Dr Smith so far agrees with him; for though he asserts, and indeed proves, that poverty is no check to the production of children, he allows it to be very unfavour-

able to raising them. See *Smith's Wealth of Nations*, vol. i. p. 119, &c. See also POOR.

POULADUFF, two remarkable great holes in the ground, about a mile west of Ross, in the county of Cork, and province of Munster, in Ireland, 80 yards deep, in which the sea flows by subterraneous passages. They are called East and West Pouladuff; one is on the lands of Downeen, and the other on Tralong.

POULTICE, a sort of medicine, called also a *cataplasm*. See CATAPLASMA.

POULTRY, all kind of domestic birds brought up in yards, as cocks, hens, capons, ducks, turkeys, &c.

Almost, if not all the domestic birds of the poultry kind that we maintain in our yards are of foreign extraction: but there are others to be ranked in this class that are as yet in a state of nature, and perhaps only wait till they become sufficiently scarce to be taken under the care of man to multiply their propagation. It will appear remarkable enough, if we consider how much the tame poultry which we have imported from distant climates has increased, and how much those wild birds of the poultry kind that have never yet been taken into keeping have been diminished and destroyed. They are all thinned; and many of the species, especially in the more cultivated and populous parts of the kingdom, are utterly unseen.

Under birds of the poultry kind may be ranked all those that have white flesh, and, comparatively to their heads and limbs, have bulky bodies. They are furnished with short strong bills for picking up grain, which is their chief and often their only sustenance. Their wings are short and concave; for which reason they are not able to fly far. They lay a great many eggs; and as they lead their young abroad, the very day they are hatched, in quest of food, which they are shown by the mother, and which they pick up for themselves, they generally make their nests on the ground. The toes of all these are united by a membrane as far as the first articulation, and are then divided.

Under this class we may therefore render the common cock, the peacock, the turkey, the pintada or Guinea hen, the pheasant, the bustard, the grouse, the partridge, and the quail. They all bear a strong similitude to each other, being equally granivorous, fleshy, and delicate to the palate. They are among birds what beasts of pasture are among quadrupeds, peaceable tenants of the field, and shunning the thicker parts of the forest, that abound with numerous animals who carry on unceasing hostilities against them.

As nature has formed the rapacious class for war, so she seems equally to have fitted these for peace, rest, and society. Their wings are but short, so that they are ill formed for wandering from one region to another: their bills are also short, and incapable of annoying their opposers: their legs are strong indeed; but their toes are made for scratching up their food, and not for holding or tearing it. These are sufficient indications of their harmless nature; while their bodies, which are fat and fleshy, render them unwieldy travellers, and incapable of straying far from each other.

Accordingly, we find them chiefly in society: they live together: and though they may have their disputes, like all other animals, upon some occasions; yet, when kept in the same district, or fed in the same

Pouladuff
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Poultry.

Pounce
&
Pouffin.

same yard, they learn the arts of subordination; and, in proportion as each knows his strength, he seldom tries a second time the combat where he has once been worsted.

In this manner, all of this kind seem to lead an indolent voluptuous life. As they are furnished internally with a very strong stomach, commonly called a *gizzard*, so their voraciousness scarce knows any bounds. If kept in close captivity, and separated from all their former companions, they have still the pleasure of eating left; and they soon grow fat and unwieldy in their prison. To say this more simply, many of the wilder species of birds, when cooped or caged, pine away, grow gloomy, and some refuse all sustenance whatever; none except those of the poultry kind grow fat, who seem to lose all remembrance of their former liberty, satisfied with indolence and plenty.

POUNCE, gum sandarach pounded and sifted very fine, to rub on paper, in order to preserve it from sinking, and to make it more fit to write upon.

POUNCE, is also a little heap of charcoal dust, inclosed in a piece of muslin or some other open stuff, to be passed over holes pricked in a work, in order to mark the lines or designs thereof on paper, silk, &c. placed underneath; which are to be afterwards finished with a pen and ink, a needle, or the like. This kind of pounce is much used by embroiderers, to transfer their patterns upon stuffs; by lace-makers, and sometimes also by engravers.

POUNCES, in falconry, the talons or claws of a bird of prey.

POUND, a standard-weight; for the proportion and subdivisions of which, see the article **WEIGHT**.

POUND also denotes a money of account; so called, because the ancient pound of silver weighed a pound Troy.

POUND, among lawyers, denotes a place of strength, in which to keep cattle that are distrained, or put in for trespass, until they are replevied or redeemed.

POUNDAGE, a subsidy of 12 d. in the pound, granted to the crown on all goods and merchandizes exported or imported; and if by aliens, one penny more.

POURPRESTURE, in law, is a wrongful inclosure, or incroachment upon another person's property.

POURSUIVANT, or **PURSUIVANT**, in heraldry, the lowest order of officers at arms.—They are properly attendants on the heralds when they marshal public ceremonies. Of these in England there were formerly many; but at present there are only four, viz. blue-mantle, rouge-cross, rouge-dragon, and port-cullice. In Scotland there is only one king at arms, who is styled *Lyon*; and has under him no less than six heralds, as many pursuivants, and a great many messengers at arms. See **LYON**.

POURVEYANCE, or **PURVEYANCE**, in law, the providing corn, fuel, victuals, &c. for the king's household; and hence the officer who did so was termed *pourveyor*. As several offences were committed by these officers, it was enacted by stat. 12. Car. II. that no person, under colour of *pourveyance*, shall take any timber, cattle, corn, &c. from any subject without his free consent, or without a just appraisement and paying for the same.

POUSSIN (Nicholas), an eminent French painter,

Poussin.
Powder.

born in 1594, at Andel, a little city in Normandy, where his father was of noble extraction, but born to a small estate. He was instructed for a few months by one Ferdinand Elle, a portrait-painter, and afterwards spent a month with L'Allemand; but finding these artists not likely to improve him suitably to his desires, he first studied the paintings of the best masters, and then hastened to finish a few pieces he was engaged in, and travelled to Italy. Here he devoted almost his whole attention to the study of antique statues and bas-reliefs; which was probably the cause of his want of knowledge in, and taste for, the art of colouring. Being invited back to Paris by Louis XIII. who assigned him a pension with lodgings in the Thuilleries, he painted for prince Justiniani an historical picture representing Herod's cruelty; an admirable composition, in which he gave such expression to every character, as could not fail to strike the beholder with terror and pity: he then laboured for several years on the celebrated pictures of the seven sacraments of the Romish church. But none of Poussin's designs have been more generally admired than that of the death of Germanicus; which would have gained him immortal honour if he had never painted another picture. He began the labours of Hercules in the gallery of the Louvre; but the faction of Vouet's school railing at him and his performances, put him so out of humour with his own country, that he returned to Rome, where he died in 1665. He never went beyond easel-pieces, for which he had a perpetual demand; and his method was to fix the price he expected on the back of the canvas, which was readily paid.

POUSSIN (Gaspar). This painter, whose real name was *Duguet*, was born at Paris in 1600; and was induced to travel to Rome, not only from a love to the art of painting, but also to visit his sister, who was married to Nicholas Poussin. Sandrart says that Gaspar was employed at first only to prepare the pallet, pencils, and colours, for Nicholas; but by the precepts and example of that excellent master, gradually rose to the highest reputation, and is undoubtedly one of the best landscape-painters that ever appeared. It is generally thought that no painter ever studied nature to better purpose, or represented the effects of land-storms more happily, than Gaspar; all his trees show a natural degree of agitation, every leaf being in motion; his scenes are all beautifully chosen, as are the sites of his buildings. He designed human figures but very indifferently; for which reason he frequently prevailed on Nicholas to paint them for him; and they were always introduced with the utmost propriety. While he continued at Rome he dropped his own name, and assumed that of his brother-in-law and benefactor, by which only he is at present known. He died in 1662.

POWDER, in pharmacy, a dry medicine well broken, either in a mortar by grinding or by some chemical operation.

GUN-POWDER. See **GUNPOWDER**. See also *Observations on Gunpowder in the Irish Transactions*, 1788, p. 97. class *Science*, by Mr Napier.

POWDER-Chests, certain small boxes charged with powder and a quantity of old nails or splinters of iron, and fastened occasionally on the deck and sides of a ship, in order to be discharged on an enemy who attempts to seize her by boarding. These cases are usually

Powder
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Powers.

ally from 12 to 18 inches in length, and about eight or ten in breadth, having their outer or upper part terminating in an edge. They are nailed to several places of the quarter-deck and bulk-head of the waist, having a train of powder, which communicates with the inner apartments of the ship, so as to be fired at pleasure to annoy the enemy. They are particularly used in merchant-ships which are furnished with close-quarters to oppose the boarders.

POWDER-Magazine, a bomb-proof arched building, to contain powder in fortified places.

POWDER for the Hair. The best sort is starch well pounded and sifted, and generally prepared with some perfume.

James's POWDER. See *JAMES'S Powder*. In the Philosophical Transactions for 1791, p. 317. there is a paper by Dr Pearson, containing experiments and observations on James's powder. Dr Pearson says, it was originally a patent medicine; but it is well known that it cannot be prepared by following the directions of the specification in the court of chancery. His observations and experiments, therefore, he thinks, may explain the nature and manner of preparing this medicine, and perhaps may extend the history of antimony. The result of the whole, in Dr Pearson's own words, is as follows:

1. James's powder consists of phosphoric acid, lime, and antimonial calx; with a minute quantity of calx of iron, which is considered to be an accidental substance.
2. Either these three essential ingredients are united with each other, forming a triple compound, or phosphorated lime is combined with the antimonial calx, composing a double compound in the proportion of about 57 parts of calx and 43 parts of phosphorated lime.
3. This antimonial calx is different from any other known calx of antimony in several of its chemical qualities. About three-fourths of it are soluble in marine acid, and afford Algaroth powder; and the remainder is not soluble in this menstruum, and is apparently vitrified. It also appears, that by calcining together bone-ashes, that is, phosphorated lime and antimony in a certain proportion, and afterwards exposing the mixture to a white heat, a compound was formed, consisting of antimonial calx and phosphorated lime in the same proportion, and possessing the same kind of chemical properties as James's powder.

POWDIKE, in the fens of Norfolk and Ely. By stat. 22 Hen. VIII. c. 11. perversely to cut down and destroy the poldike in the fens of Norfolk and Ely is felony. See *Blackstone's Commentaries*, vol. iv. p. 243.

POWER, has been defined the faculty of doing or suffering any thing. Power, therefore, is two-fold, viz. considered as able to make, or able to receive, any change; the former whereof may be called *active*, and the latter *passive power*: but this distinction is improper. See *METAPHYSICS*, n° 116.

POWER, in mechanics, denotes any force, whether of a man, a horse, a spring, the wind, water, &c. which, being applied to a machine, tends to produce motion.

POWER, in law, signifies in general a particular authority granted by any person to another to represent him, or to act in his stead.

POWERS, in arithmetic and algebra, are nothing but the products arising from the continual multiplications of a number or quantity into itself. See *ALGEBRA* and *ARITHMETIC*.

POX, *French-Pox*, or *Lues Venerea*. See *MEDICINE*, n° 350.

Small-Pox. See *INOCULATION*, and *MEDICINE*, n° 222—226.

POYNING's LAW, an act of parliament made in Ireland under Henry VII. whereby all the statutes of force in England were made of force in Ireland; which before that time they were not.—Nor are any now in force there made in England since that time.

The law took its name from Sir Edward Poyning, lord-lieutenant of that kingdom at the time of its making. See *IRELAND*, n° 46.

POZZOLANA. See *PUZZOLANA*.

PRACTICE, in arithmetic. See there, n° 16. &c.

Gun-PRACTICE, in military education. In the spring, as soon as the weather permits, the exercise of the great guns begins, with an intention to show the gentlemen cadets at the royal military academy at Woolwich, and private men, the manner of laying, loading, pointing, and firing the guns. Sometimes instruments are used to find the centre line, or two points, one at the breech, the other at the muzzle, which are marked with chalk, and whereby the piece is directed to the target: then a quadrant is put into the mouth to give the gun the required elevation, which at first is guessed at, according to the distance the target is from the piece. When the piece has been fired, it is sponged to clear it from any dust or sparks of fire that might remain in the bore, and loaded: then the centre line is found as before; and if the shot went too high or too low, to the right or to the left, the elevation and trail are altered accordingly. This practice continues morning and evening for about six weeks, more or less according as there are a greater or less number of recruits. In the mean time others are shown the motions of quick-firing with field-pieces.

Mortar-PRACTICE, generally thus. A line of 1500 or 2000 yards is measured in an open spot of ground from the place where the mortars stand, and a flag fixed at about 300 or 500 yards: this being done, the ground where the mortars are to be placed is prepared and levelled with sand, so that they may lie at an elevation of 45 degrees; then they are loaded with a small quantity of powder at first, which is increased afterwards by an ounce every time, till they are loaded with a full charge; the times of the flights of the shells are observed, to determine the length of the fuzes. The intention of this practice is, when a mortar battery is raised in a siege, to know what quantity of powder is required to throw the shells into the works at a given distance, and to cut the fuzes of a just length, that the shell may burst as soon as it touches the ground.

PRÆMUNIRE, in law, is taken either for a writ so called, or for the offence whereon the writ is granted; the one may be understood by the other.—The church of Rome, under pretence of her supremacy and the dignity of St Peter's chair, took on her to bestow most of the ecclesiastical livings of any worth in England, by mandates, before they were void; pretending therein great care to see the church provided of a successor before it needed. Whence these mandates or bulls were called *gratia expectativa*, or *provisiones*; whereof see a learned discourse in *Duarenus de beneficiis*,

Pox
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Præmunire.

Præmunire.

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Comment.

beneficiis, lib. 3. cap. 1. These provisions were so common, that at last Edward I. not digesting so intolerable an encroachment, in the 35th year of his reign made a statute against papal provisions, which, according to Sir Edward Coke, is the foundation of all the subsequent statutes of *præmunire*: which is ranked as an offence immediately against the king, because every encouragement of the papal power is a diminution of the authority of the crown.

In the weak reign of Edward II. the pope again endeavoured to encroach, but the parliament manfully withstood him; and it was one of the articles charged against that unhappy prince, that he had given allowance to the bulls of the see of Rome. But Edw. III. was of a temper extremely different; and, to remedy these inconveniences, first by gentle means, he and his nobility wrote an expostulation to the pope: but receiving a menacing and contemptuous answer, withal acquainting him, that the emperor (who a few years before at the diet of Nuremberg, A. D. 1323, had established a law against provisions), and also the king of France, had lately submitted to the holy see; the king replied, that if both the emperor and the French king should take the pope's part, he was ready to give battle to them both, in defence of the liberties of the crown. Hereupon more sharp and penal laws were devised against provisors, which enact severally, that the court of Rome shall present or collate to no bishopric or living in England; and that whoever disturbs any patron in the presentation to a living by virtue of a papal provision, such provisor shall pay fine and ransom to the king at his will, and be imprisoned till he renounces such provision; and the same punishment is inflicted on such as cite the king, or any of his subjects, to answer in the court of Rome. And when the holy see resent these proceedings, and pope Urban V. attempted to revive the vassalage and annualrent to which king John had subjected his kingdom, it was unanimously agreed by all the estates of the realm in parliament assembled, 40 Edw. III. that king John's donation was null and void, being without the concurrence of parliament, and contrary to his coronation-oath; and all the temporary nobility and commons engaged, that if the pope should endeavour by process or otherwise to maintain these usurpations, they would resist and withstand him with all their power.

In the reign of Richard II. it was found necessary to sharpen and strengthen these laws, and therefore it was enacted by statutes 3 Ric. II. c. 3. and 7 Ric. II. c. 12. first, that no alien shall be capable of letting his benefice to farm; in order to compel such as had crept in, at least to reside on their preferments: and afterwards, that no alien should be capable to be presented to any ecclesiastical preferment, under the penalty of the statutes of provisors. By the statute 12 Rich. II. c. 15. all liegemen of the king accepting of a living by any foreign provision, are put out of the king's protection, and the benefice made void. To which the statute 13 Rich. II. st. 2. c. 2. adds banishment and forfeiture of lands and goods: and by c. 3. of the same statute, any person bringing over any citation or excommunication from beyond sea, on account of the execution of the foregoing statutes of provisors, shall be imprisoned; forfeit his goods and lands, and moreover suffer pain of life and member.

In the writ for the execution of all these statutes, the words *præmunire facias* being used to command a citation of the party, have denominated in common speech, not only the writ, but the offence itself of maintaining the papal power, by the name of *præmunire*. And, accordingly, the next statute we shall mention, which is generally referred to by all subsequent statutes, is usually called the *statute of præmunire*. It is the statute 16 Richard II. c. 5. which enacts, that whoever procures at Rome, or elsewhere, any translations, processes, excommunications, bulls, instruments, or other things which touch the king, against him, his crown, and realm, and all persons aiding and assisting therein, shall be put out of the king's protection, their lands and goods forfeited to the king's use, and they shall be attached by their bodies to answer to the king and his council; or process of *præmunire facias* shall be made out against them as in other cases of provisors.

By the statute 2 Henry IV. c. 3. all persons who accept any provision from the pope, to be exempt from canonical obedience to their proper ordinary, are also subjected to the penalties of *præmunire*. And this is the last of our ancient statutes touching this offence; the usurped civil power of the bishop of Rome being pretty well broken down by these statutes, as his usurped religious power was in about a century afterwards: the spirit of the nation being so much raised against foreigners, that about this time, in the reign of Hen. V. the alien priories, or abbeys for foreign monks, were suppressed, and their lands given to the crown. And no farther attempts were afterwards made in support of these foreign jurisdictions.

This, then, is the original meaning of the offence which we call *præmunire*; viz. introducing a foreign power into this land, and creating *imperium in imperio*, by paying that obedience to papal process which constitutionally belonged to the king alone, long before the Reformation in the reign of Henry VIII. at which time the penalties of *præmunire* were indeed extended to more papal abuses than before; as the kingdom then entirely renounced the authority of the see of Rome, though not at all the corrupted doctrines of the Roman church. And therefore, by the several statutes of 24 Hen. VIII. c. 12. and 25 Hen. VIII. c. 19. & 21. to appeal to Rome from any of the king's courts, which (though illegal before) had at times been connived at; to sue to Rome for any licence or dispensation, or to obey any process from thence, are made liable to the pains of *præmunire*. And, in order to restore to the king in effect the nomination of vacant bishoprics, and yet keep up the established forms, it is enacted by statute 25 Hen. VIII. c. 20. that if the dean and chapter refuse to elect the person named by the king, or any archbishop or bishop to confirm or consecrate him, they shall fall within the penalties of the statutes of *præmunire*. Also by statute 5 Eliz. c. 1. to refuse the oath of supremacy will incur the pains of *præmunire*; and to defend the pope's jurisdiction in this realm, is a *præmunire* for the first offence, and high treason for the second. So, too, by statute 13 Eliz. c. 2. to import any *agnus Dei*, crosses, beads, or other superstitious things, pretended to be hallowed by the bishop of Rome, and tender the same to be used; or to receive the same with such intent, and not discover the offender; or if a justice of the peace, knowing thereof, shall not within

Præmunire.

Præmunire.

14 days declare it to a privy-counsellor, they all incur a præmunire. But importing or selling mass-books, or other Popish books, is by stat. 3 Jac. I. c. 5. § 25. only liable to a penalty of 40 s. Lastly, to contribute to the maintenance of a Jesuit's college, or any Popish seminary whatever beyond sea, or any person in the same, or to contribute to the maintenance of any Jesuit or Popish priest in England, is by statute 27 Eliz. c. 2. made liable to the penalties of præmunire.

Thus far the penalties of præmunire seem to have kept within the proper bounds of their original institution, the depressing the power of the pope: but they being pains of no considerable consequence, it has been thought fit to apply the same to other heinous offences; some of which bear more, and some less, relation to this original offence, and some no relation at all.

Thus, 1. By the statute 1 & 2 Ph. and Mar. c. 8. to molest the possessors of abbey-lands granted by parliament to Henry VIII. and Edward VI. is a præmunire. 2. So likewise is the offence of acting as a broker or agent in any usurious contract where above 10 per cent. interest is taken, by statute 13 Eliz. c. 10. 3. To obtain any stay of proceedings, other than by arrest of judgment or writ of error, in any suit for a monopoly, is likewise a præmunire, by stat. 21 Jac. I. c. 3. 4. To obtain an exclusive patent for the sole making or importation of gunpowder or arms, or to hinder others from importing them, is also a præmunire by two statutes; the one 16 Car. I. c. 21. the other 1 Jac. II. c. 8. 5. On the abolition, by stat. 12. Car. II. c. 24. of purveyance, and the prerogative of pre-emption, or taking any victual, beasts, or goods for the king's use, at a stated price, without consent of the proprietor, the exertion of any such power for the future was declared to incur the penalties of præmunire. 6. To assert, maliciously and advisedly, by speaking or writing, that both or either house of parliament have a legislative authority without the king, is declared a præmunire by statute 13 Car. II. c. 1. 7. By the *habeas corpus* act also, 31 Car. II. c. 2. it is a præmunire, and incapable of the king's pardon, besides other heavy penalties, to send any subject of this realm a prisoner into parts beyond the seas. 8. By the statute 1 W. & M. st. 1. c. 8. persons of 18 years of age refusing to take the new oaths of allegiance as well as supremacy, upon tender by the proper magistrate, are subject to the penalties of a præmunire; and by statutes 7 & 8 W. III. c. 24. serjeants, counsellors, proctors, attorneys, and all officers of courts, practising without having taken the oaths of allegiance and supremacy, and subscribed the declaration against popery, are guilty of a præmunire whether the oaths be tendered or not. 9. By the statute 6 Ann. c. 7. to assert maliciously and directly, by preaching, teaching, or advised speaking, that the then pretended prince of Wales, or any person other than according to the acts of settlement and union, hath any right to the throne of these kingdoms, or that the king and parliament cannot make laws to limit the descent of the crown; such preaching, teaching, or advised speaking, is a præmunire: as writing, printing, or publishing the same doctrines amounted, we may remember, to high treason. 10. By statute 6 Ann. c. 23. if the assembly of peers of Scotland, convened to elect their 16 representatives in the British parliament, shall presume to treat of any other matter save only the election, they incur the penalties

of a præmunire. 11. The stat. 6 Geo. I. c. 18. (enacted in the year after the infamous South Sea project had beggared half the nation) makes all unwarrantable undertakings by unlawful subscriptions, then commonly known by the name of *bubbles*, subject to the penalties of a præmunire. 12. The stat. 12 Geo. III. c. 11. subjects to the penalties of the statute of præmunire all such as knowingly and wilfully solemnize, assist, or are present at, any forbidden marriage of such of the descendants of the body of king Geo. II. as are by that act prohibited to contract matrimony without the consent of the crown.

Having thus inquired into the nature and several species of præmunire, its punishment may be gathered from the foregoing statutes, which are thus shortly summed up by Sir Edward Coke: "That, from the conviction, the defendant shall be out of the king's protection, and his lands and tenements, goods and chattels, forfeited to the king; and that his body shall remain in prison at the king's pleasure, or (as other authorities have it) during life; both which amount to the same thing, as the king by his prerogative may any time remit the whole, or any part of the punishment, except in the case of transgressing the statute of *habeas corpus*. These forfeitures here inflicted do not (by the way) bring this offence within our former definition of FELONY; being inflicted by particular statutes, and not by the common law." But so odious, Sir Edward Coke adds, was this offence of præmunire, that a man that was attainted of the same, might have been slain by any other man without danger of law; because it was provided by law, that any man might do to him as to the king's enemy; and any man may lawfully kill an enemy. However, the position itself, that it is at any time lawful to kill an enemy, is by no means tenable: it is only lawful, by the law of nature and nations, to kill him in the heat of battle, or for necessary self defence. And to obviate such savage and mistaken notions, the statute 5 Eliz. c. 1. provides, that it shall not be lawful to kill any person attainted in a præmunire, any law, statute, opinion, or exposition of law to the contrary notwithstanding. But still such delinquent, though protected as a part of the public from public wrongs, can bring no action for any private injury, how atrocious soever; being so far out of the protection of the law, that it will not guard his civil rights, nor remedy any grievance which he as an individual may suffer. And no man, knowing him to be guilty, can with safety give him comfort, aid, or relief.

PRÆNESIÆ (anc. geog.), a town of Latium, to the south-east of Rome, towards the territory of the Æqui; a place of great strength. Famous for the temple and oracle of Fortune, called *Sortes Prænestinae* (Strabo); which Tiberius wanted to destroy, but was deterred by the awful majesty of the place. From a colony it was raised to a municipium by Tiberius (Inscriptions, Florus, A. Gellius), on the consideration of his recovery from a dangerous illness near this place. Thither the Roman emperors usually retired, on account of the agreeableness of the situation (Suetonius). It was a very ancient city, with a territory of large extent (Livy). The temple of Fortune was built in the most sumptuous manner by Sylla, and the pavement was Mosaic work (Pliny). Concerning the Sortes, there is a remarkable passage in Cicero; who says, that it was all

Præmunire, Prænestinae.

Præsidium a mere contrivance, in order to deceive, either for the purposes of gain or superstition. The town that has succeeded it stands low in a valley, and is called *Palestrina*, in the Campania of Rome. E. Long. 13. 30. N. Lat. 42. 0.

PRÆSIDIUM (Notitia), a town of the Cornavii in Britain. Now thought to be Warwick (Camden).—Another of Corsica (Antonine), 30 miles to the south of Aleria.—A third *Præsidium* surnamed *Julium*, in Bætica (Pliny).

PRÆTORIA AUGUSTA (Ptolemy), a town of Dacia. Now called *Brassow* by the natives, and *Cronstat* by the Germans (Baudrand): a town in Transylvania. E. Long. 25°. N. Lat. 47°.—Another of the Salassii, near the two gates or defiles of the Alps, the Grajæ and Penninæ (Pliny); a Roman colony, settled by Augustus after the defeat of the Salassii by Terentius Varro, on the spot where he encamped (Strabo, Dio Cassius, Ptolemy), situated on the river Duria Major. The town is now called *Aosta* or *Aouft*, in Piedmont. E. Long. 7. 14. N. Lat. 45. 19.

PRÆTORIUM (Antonine, Notitia Imperii), a town of the Brigantes. Now *Paterington* (Camden), near the mouth of the Humber in Yorkshire. *Coventry* (Talbot).

PRAGMATIC SANCTION, in the civil law, is defined by Hottoman to be a rescript or answer of the sovereign, delivered by advice of his council, to some college, order, or body of people, upon consulting him on some case of their community. The like answer given to any particular person is called simply *rescript*.

The term *pragmatic sanction* is chiefly applied to a settlement of Charles VI. emperor of Germany, who, in the year 1722, having no sons, settled his hereditary dominions on his eldest daughter the archduchess Maria Theresa, which was confirmed by the diet of the empire, and guaranteed by Great Britain, France, the States-General, and most of the powers in Europe. The word *pragmatic* is derived from the Greek *πραγμα*, *negotium*, "business."—It is sometimes also called absolutely *pragmatic*, το *πραγματικον*.

PRAGUE, a city of Bohemia, and capital of the whole kingdom, is situated 14° 40' of longitude, and 50° 5' of latitude. It stands on both sides the Moldau, over which there is a bridge 700 feet long, built of large freestone. The river, though of great breadth here, is nevertheless shallow, and not navigable. On both sides the bridge are several statues, and among others that of St John of Nepomuck, whom king Wensel caused to be thrown from the bridge into the river, for venturing to reprove him upon some occasion; but in 1720 he was canonized as a saint, and is at present held in such veneration in Bohemia, that all other saints seem on his account to be forgotten. Near the bridge, which stands at the upper part of the city, the number of people is very great, but the further you go from thence the more desolate you find every place. The city is about three miles long and two broad; the number of its Christian inhabitants is said to be 70,000, and of Jews about 12,000. The principal branch of its trade consists in brewing of beer. It is divided into the Old and the New Towns, and that called the *Small side*; the former lying on the east side of the Moldau, and the latter on the west. The whole is about 12 miles in circumference. The fortifications are not of

great importance, as it may be flanked and raked on all sides. However, the king of Prussia was not able to make himself master of it in the late war, though he almost destroyed it with his bombs, &c. See *PRUSSIA*, n° 24, &c.—It hath suffered greatly by sieges, and hath been often taken and plundered. The university was founded by Charles IV. in the year 1347. In 1409, when John Hufs was rector of the university, there were no less than 44,000 students; and when the emperor Charles V. would have retrenched their privileges, 24,000 are said to have left it in one week, and 16,000 in a short time after. The Jews have the trade of this city almost entirely in their own hands. They deal in all sorts of commodities, especially the precious stones found in the Bohemian mines, and, by receiving all old-fashioned things in payment, quite ruin the Christian handicraftsmen. In 1744 they narrowly escaped being expelled the kingdom, having been suspected of corresponding with the Prussians, when they made themselves masters of the city. The grand prior of the order of Malta, for Bohemia, Moravia, and Silesia, resides here; and the church and hospital of the Holy Ghost is the seat of the general and grandmasters of the holy order of knights of the cross with the red star, residing in the above-mentioned countries, and in Poland and Hungary. The houses of this city are all built of stone, and generally consist of three stories; but there are very few good buildings in it, and almost every thing looks dirty. The cathedral, which is dedicated to St Veit, is an old building, in which there are some pieces of excellent architecture and many magnificent tombs of great men. There are 100 churches and chapels, and about 40 cloisters in the place. On Ratschin-hill, in Upper Prague, most of the nobility have houses, and the emperor a very magnificent palace, and a summer-house commanding one of the finest prospects in the world. Here the tribunals of the regency meet; and the halls, galleries, and other apartments, are adorned with a multitude of noble pictures. The great hall, where the coronation feast is kept, is said to be the largest of the kind in Europe next to that of Westminster. The castle stands on the above-mentioned mountain, called *Ratschin* or the *White Mountain*, and is very strong. From a window of this castle the emperor's counsellors were thrown in 1618; but though they fell from a great height, yet they were not killed, nor indeed much hurt. On the same mountain stands also the archiepiscopal palace. In the New Town is an arsenal, and a religious foundation for ladies, called the *Free Temporal English Foundation*, over which an abbess presides. In the Lesser Side or Town, the counts Colloredo and Wallenstein have very magnificent palaces and gardens. The stables of the latter are very grand; the racks being of steel and the mangers of marble, and a marble pillar betwixt each horse; over each horse also is placed his picture as big as life. Though the inhabitants of Prague in general are poor, and their shops but meanly furnished, yet, it is said, there are few cities where the nobility and gentry are more wealthy, and live in greater state. Here is much gaming, masquerading, feasting, and very splendid public balls, with an Italian opera, and assemblies in the houses of the quality every night. On the White Mountain, near the town, was fought the battle in which the Protestants, with the elector Palatine Frederic their king, were defeated.

Prague.

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Pratt.

The lustres and drinking-glasses made here of Bohemian crystal are much esteemed, and vended all over Europe. These crystals are also polished by the Jews, and set in rings, ear-pendants, and shirt-buttons. The chief tribunal consists of twelve stadtholders, at the head of whom is the great burgrave, governor of the kingdom and city, immediately under the emperor, and the chancery of Bohemia. Though the city of Prague is very ill-built, it is pleasantly situated, and some of the prospects are beautiful, and the gardens and pleasure-houses are excellent. The people, Riebeck informs us, enjoy sensual pleasures more than those of Vienna, because they know better how to connect mental enjoyments with them. The numerous garrison kept in the place (9000 men) contributes much to its gaiety and liveliness.

PRAM, or PRAME, a kind of lighter used in Holland and the ports of the Baltic Sea, to carry the cargo of a merchant-ship *along-side*, in order to lade or to bring it to shore to be lodged in the storehouses after being discharged out of the vessel.

PRAME, in military affairs, a kind of floating battery, being a flat-bottomed vessel, which draws little water, mounts several guns, and is very useful in covering the disembarkation of troops. They are generally made use of in transporting troops over the lakes in America.

PRAMNION, in natural history, the name of a semipellucid gem. This is a very singular stone, and of a very great concealed beauty. Our lapidaries, when they meet with it, call it by the name of the *black agate*. It is of an extremely close, compact, and firm texture, of a smooth and equal surface, and in shape very irregular, being sometimes round, sometimes oblong, and often flat; in size it seldom exceeds two inches. It appears, on a common inspection, to be of a fine deep black; but held up against the sun or the light of a candle, it is an elegant red, clouded by a quantity of subtle black earth. We have it from the East Indies.

PRASIMUM, in botany: A genus of the gymnospermia order, belonging to the didynamia class of plants; and in the natural method ranking under the 42d order, *Verticillata*. There are four monospermous berries.

PRATINAS, a Greek poet contemporary with Æschylus, born at Phlius. He was the first among the Greeks who composed satires, which were represented as farces. Of these 32 were acted, as also 18 of his tragedies, one of which only obtained the poetical prize. Some of his verses are extant, quoted by Athenæus.

PRATIQUE, or PRATTIC, in commerce, a negotiation or communication of commerce which a merchant vessel obtains in the port it arrives in and the countries it discovers: hence to obtain a pratique, is to obtain liberty to frequent a port, to go ashore, to buy and sell, &c.

PRATT (Charles), earl of Camden, was the third son of Sir John Pratt, knight, chief-justice of the court of king's-bench under George I. by his second wife Elizabeth, daughter of the Reverend Hugh Wilson canon of Bangor, and was born in 1713, the year before his father was called to the honour of the bench. He received the first rudiments of his education at Eton,

and afterwards removed to king's college Cambridge. Of his early life at both places there is little known, other than that at college he was found to be remarkably diligent and studious, and particularly so in the history and constitution of this country. By some he was thought to be a little too tenacious of the rights and privileges of the college he belonged to; but perhaps it was to this early tendency that we are indebted for those noble struggles in defence of liberty, which, whether in or out of office, he displayed through the whole course of his political life. After staying out the usual time at college, and taking his master's degree, in 1739 he entered himself a student of the Inner Temple, and was in due time admitted by that honourable society as a barrister at law. And here a circumstance develops itself in the history of this great man, which shows how much chance governs in the affairs of this world, and that the most considerable talents and indisputable integrity will sometimes require the introduction of this mistress of the ceremonies, in order to obtain that which they ought to possess from their own intrinsic qualifications.

Mr Pratt, after his being called to the bar, notwithstanding his family introduction, and his own personal character, was very near nine years in the profession, without ever getting in any degree forward. Whether this arose from a natural timidity of constitution, ill-luck, or perhaps a mixture of despondence growing out of the two circumstances, it is now difficult to tell; but the fact was so: and he was so dispirited by it, that he had some thoughts of relinquishing the profession of the law, and retiring to his college, where, in rotation, he might be sure of a church living, that would give him a small but honourable independence. With these melancholy ideas he went as usual the western circuit, to make one more experiment, and then to take his final determination. Mr Henley, afterwards Lord Northington and chancellor of England, was in the same circuit: he was Mr Pratt's most intimate friend; and he now availed himself of that friendship, and told him his situation, and his intentions of retiring to the university and going into the church. He opposed his intention with strong raillery, and got him engaged in a cause along with himself; and Mr Henley being ill, Mr Pratt took the lead, and displayed a professional knowledge and elocution that excited the admiration of his brother barristers as much as that of the whole court. He gained his cause; and besides, he acquired the reputation of an eloquent, profound, and constitutional lawyer. It was this circumstance, together with the continued good offices of his friend Henley, which led to his future greatness; for with all his abilities and all his knowledge, he might otherwise in all probability have passed his life in obscurity unnoticed and unknown.

He became now one of the most successful pleaders at the bar, and honours and emoluments flowed thick upon him. He was chosen to represent the borough of Downton, Wilts, after the general election in 1759; recorder of Bath 1759; and the same year was appointed attorney-general; in January 1762 he was called to the degree of serjeant at law, appointed chief-justice of the common pleas, and knighted. His Lordship presided in that court with a dignity, weight, and impartiality, never exceeded by any of his predecessors; and when John Wilkes, Esq; was seized and committed to the Tower on an illegal

Pratt.

general

Pratt.

general warrant, his Lordship, with the intrepidity of a British magistrate, and the becoming fortitude of an Englishman, granted him an *habeas corpus*; and on his being brought before the court of common pleas, discharged him from his confinement in the Tower, May 6. 1763, in a speech which did him honour. His wife and spirited behaviour on this remarkable occasion, so interesting to every true-born Briton, and in the consequent judicial proceedings between the printers of The North Briton and the messengers and others, was so acceptable to the nation, that the city of London presented him with the freedom of their corporation in a gold box, and desired his picture, which was put up in Guildhall, with this inscription:

HANC ICONEM
CAROLI PRATT, EQ.
SUMMI JUDICIS C. B.
IN HONOREM TANTI VIRI,
ANGLICÆ LIBERTATIS LEGE
ASSERTORIS,
S. P. Q. L.
IN CURIA MUNICIPALI
PONI JVSSE RVNT
NONO KAL. MART. A. D. MDCCCLXIV.
GULIELMO BRIDGEN, AR. PRÆ. VRB.

This portrait, painted by Reynolds, was engraved by Basire. The corporations of Dublin, Bath, Exeter, and Norwich, paid him the like compliment; and in a petition entered in the journals of the city of Dublin, it was declared, that no man appeared to have acquitted himself in his high station with such becoming zeal for the honour and dignity of the crown, and the fulfilling his majesty's most gracious intentions for preserving the freedom and happiness of his subjects, and such invincible fortitude in administering justice and law, as the Right Honourable Sir Charles Pratt, knight, the present lord-chief-justice of his majesty's court of common pleas in England, has shown in some late judicial determinations, which must be remembered to his lordship's honour while and wherever British liberties are held sacred.

Higher honours, however, than the breath of popular applause awaited Sir Charles Pratt. On the 16th of July 1765 he was created a peer of Great Britain, by the style and title of Lord Camden, Baron Camden, in the county of Kent; and, July 30. 1766, on the resignation of Robert earl of Northampton, he was appointed lord high-chancellor of Great Britain; in which capacity he, in a speech of two hours, declared, upon the first decision of the suit against the messengers who arrested Mr Wilkes, that "it was the unanimous opinion of the whole court, that general warrants, except in cases of high treason, were illegal, oppressive, and unwarrantable. He conducted himself in this high office so as to obtain the love and esteem of all parties; but when the taxation of America was in agitation, he declared himself against it, and strongly opposing it, was removed from his station in 1770.

Upon the fall of Lord North he was again taken into the administration, and on the 27th of March 1782 appointed president of the council; an office which he resigned in March 1783. On the 13th of May 1786, he was created Viscount Bayham of Bayham abbey Kent, and Earl Camden.

Whether we consider Earl Camden as a *statesman*, called to that high situation by his talents; as a *lawyer*,

defending, supporting, and enlarging the constitution; or as a *man* sustaining both by his firmness and unshaken integrity—in all he excites our general praise; and when we contemplate his high and exalted virtue, we must allow him to have been an honour to his country. He died on the 18th of April 1794 at his house in Hill-street, Berkeley-square, being at that time president of his majesty's most honourable privy-council, a governor of the charter-house, recorder of the city of Bath, and F. R. S.

He married Elizabeth, daughter and coheir of Nicholas Jafferys, Esq; son and heir of Sir Jeffery Jafferys of Brecknock priory, knight, who died in December 1779, and by whom he had issue John Jafferys Pratt (now Lord Camden), born 1759, M. P. for Bath, commissioner of the admiralty, 1782, resigned and reappointed 1783; and four daughters, Frances, married, 1775, Robert Stewart, Esq; of Mount Stewart, county of Down, 1779, and M. P. for that county; Elizabeth, single; Sarah, married Nicholas Saintfield, Esq; county of Down, 1779; Jane, married 1780 William Head James, Esq; son and heir of Sir F. Head of Langley, county of Bucks. His seat at Camden place, Chiselmurst, was the residence of the great William Camden; on whose death it came by several intermediate owners to Welton, Spencer, and Pratt, and was much improved by his Lordship. His remains were interred in the family burying-place at Seal, in Kent.

PRAXAGORAS, a native of Athens, at 107 years of age composed the History of the Kings of Athens, in two books; and at 22 the Life of Constantine the Great, in which, though a pagan, he speaks very advantageously of that prince. He also wrote the History of Alexander the Great. He lived under Constantius about the year 345.

PRAXITELES, a very famous Greek sculptor, who lived 330 years before Christ, at the time of the reign of Alexander the Great. All the ancient writers mention his statues with a high commendation, especially a Venus executed by him for the city of Cnidos, which was so admirable a piece, that king Nicomedes offered to release the inhabitants from their tribute as the purchase of it; but they refused to part with it. The inhabitants of the isle of Cos requested of Praxiteles a statue of Venus; and in consequence of this application the artist gave them their choice of two; one of which represented the goddess entirely naked, and the other covered with drapery. Both of these were of exquisite workmanship; although the former was esteemed the most beautiful, nevertheless the inhabitants of Cos had the wisdom to give the preference to the latter, from a conviction that no motive whatever could justify their introducing into their city any indecent statues or paintings, which are so likely to inflame the passions of young people, and lead them to immorality and vice. What a reproach will this be to many Christians!—He was one of the gallants of Phryne the celebrated courtesan.

PRAYER, a solemn address to God, which, when it is of any considerable length, consists of *adoration, confession, supplication, intercession, and thanksgiving*.

By *adoration* we express our sense of God's infinite perfections, his power, wisdom, goodness, and mercy; and acknowledge that our constant dependence is upon Him by whom the universe was created and has been

Pratt

Prayer.

Prayer.

hitherto preserved. By *confession* is meant our acknowledgment of our manifold transgressions of the divine laws, and our consequent unworthiness of all the good things which we enjoy at present or expect to be conferred upon us hereafter. In *supplication* we intreat our omnipotent Creator and merciful Judge, not to deal with us after our iniquities, but to pardon our transgressions, and by his grace to enable us to live henceforth righteously, soberly, and godly, in this present world; and by Christians this intreaty is always made in the name and through the mediation of Jesus Christ, because to them it is known that there is none other name under heaven given unto men whereby they may be saved. To these supplications for mercy we may likewise add our prayers for the necessities of life; because if we seek *first* the kingdom of God and his righteousness, we are assured that such things shall be added unto us. *Intercession* signifies those petitions which we offer up for others, for friends, for enemies, for all men, especially for our lawful governors, whether supreme or subordinate. And *thanksgiving* is the expression of our gratitude to God, the giver of every good and perfect gift, for all the benefits enjoyed by us and others, for the means of grace, and for the hope of glory. Such are the component parts of a regular and solemn prayer, adapted either for the church or for the closet. But an ejaculation to God, conceived on any emergency, is likewise a prayer, whether it be uttered by the voice or suffered to remain a mere affection of the mind; because the Being to whom it is addressed discerneth the thoughts of the heart.

That prayer is a duty which all men ought to perform with humility and reverence, has been generally acknowledged as well by the untaught barbarian as by the enlightened Christian; and yet to this duty objections have been made by which the understanding has been bewildered in sophistry and affronted with jargon. "If God be independent, omnipotent, and possessed of every other perfection, what pleasure, it has been asked, can he take in our acknowledgment of these perfections? If he knows all things past, present, and future, where is the propriety of our confessing our sins unto him? If he is a benevolent and merciful Being, he will pardon our sins, and grant us what is needful for us without our supplications and intreaties; and if he be likewise possessed of infinite wisdom, it is certain that no importunities of ours will prevail upon him to grant us what is improper, or for our sakes to change the equal and steady laws by which the world is governed.

- "Shall burning Ætna, if a sage requires,
- "Forget to thunder, and recal her fires?
- "On air or sea new motions be imprest,
- "Oh blameless Bethel! to relieve thy breast?
- "When the loose mountain trembles from on high,
- "Shall gravitation cease, if you go by?
- "Or some old temple, nodding to its fall,
- "For Chartres' head reserve the hanging wall*?"

Such are the most plausible objections which are usually made to the practice of prayer; and though they have been set off with all the art of the metaphysical wrangler, and embellished with all the graces of the poetry of Pope, they appear to us such gross sophisms as can operate only on a very unthinking head, or on a very corrupt heart. For if God certainly ex-

ists, and there is not a mathematical theorem capable of more rigid demonstration, it is obvious that no man can think of such a being without having his mind strongly impressed with the conviction of his own constant dependence upon him; nor can he "contemplate the heavens, the work of God's hands, the moon, and the stars which he has ordained," without forming the most sublime conceptions that he can of the Divine power, wisdom, and goodness, &c. But such conviction, and such conceptions, whether clothed in words or not, are to all intents and purposes what is meant by adoration; and are as well known to the Deity while they remain the silent affections of the heart, as after they are spoken in the beginning of a prayer. Our adoration, therefore, is not expressed for the purpose of giving information to God, who understandeth our thoughts afar off; but merely, when the prayer is private, because we cannot think any more than speak without words, and because the very *sound* of words that are well chosen affects the heart, and helps to fix our attention: and as the Being who sees at once the past, present, and to come, and to whom a thousand years are but as one day, stands not in need of our information; so neither was it ever supposed by a man of rational piety, that he takes pleasure on his *own* account in hearing his perfections enumerated by creatures of yesterday; for being independent, he has no passions to be gratified, and being self-sufficient, he was as happy when existing alone as at that moment "when the morning stars sang together, and all the sons of God shouted for joy." Adoration is therefore proper only as it tends to preserve in our minds just notions of the Creator and Governor of the world, and of our own constant dependence upon him; and if such notions be useful to ourselves, who have a part to act in the scale of existence, upon which our happiness depends (a proposition which no thief will controvert), adoration must be acceptable to that benevolent God; who, when creating the world, could have no other end in view than to propagate happiness. See METAPHYSICS, n° 312.

By the same mode of reasoning, it will be easy to show the duty of *confession* and *supplication*. We are not required to confess our sins unto God, because he is ignorant of them; for he is ignorant of nothing. If he were, no reason could be assigned for our divulging to our judge actions deserving of punishment. Neither are we required to cry for mercy, in order to move him in whom there is no variableness, neither shadow of turning. The Being that made the world, governs it by laws that are inflexible, because they are the best; and to suppose that he can be induced by prayers, oblations, or sacrifices, to vary his plan of government, is an impious thought, which degrades the Deity to a level with man. One of these inflexible laws is the connection established between certain dispositions of mind and human happiness. We are enjoined to pursue a particular course of conduct under the denomination of virtue, not because our virtuous actions can in any degree be of advantage to him by whom we were created, but because they necessarily generate in our own minds those dispositions which are essential to our ultimate happiness. A man of a malignant, arrogant, or sensual disposition, would have no enjoyment in that heaven, where all are actuated by a spirit of love and purity; and it is doubtless for this reason among others, that the Christian religion prohibits

Prayer.

Prayer.

prohibits malice, arrogance, and sensuality, among her votaries, and requires the cultivation of the opposite virtues. But a person who has deviated far from his duty cannot think of returning, unless he be previously convinced that he has gone astray. Such conviction, whenever he obtains it, will necessarily impress upon his mind a sense of his own danger, and fill his heart with sorrow and remorse for having transgressed the laws established by the most benevolent of all Beings for the propagation of universal felicity. This conviction of error; this sense of danger, and this compunction for having transgressed, are all perceived by the Deity as soon as they take place in the mind of the sinner; and he is required to *confess* his sins, only because the act of confession tends to imprint more deeply on his mind his own unworthiness, and the necessity of returning immediately into the paths of that virtue of which all the ways are pleasantness and all the paths are peace.

In the objection, it is taken for granted, that if God be a benevolent and merciful Being, he will pardon our sins, and grant us what is needful for us, whether we supplicate him or not: but this is a gross and palpable mistake, arising from the objector's ignorance of the end of virtue and the nature of man. Until a man be sensible of his sins and his danger, he is for the reason already assigned incapable of pardon, because his disposition is incompatible with the happiness of the blessed. But whenever he acquires this conviction, it is impossible for him not to form a *mental wish* that he may be pardoned; and this wish being perceptible to the all-seeing eye of his Judge, forms the sum and substance of a supplication for mercy. If he clothe it in words, it is only for a reason similar to that which makes him adore his Creator and confess his sins in words, that just notions may be more deeply imprinted on his own mind. The same reasoning holds good with respect to those prayers which we put up for temporal blessings, for protection and support in our journey through life. We are told by high authority, that "the Lord is nigh unto all them that call upon him, to all that call upon him in truth." This, however, is not because he is attracted or delighted by their prayers and intreaties, but because those prayers and intreaties fit such as offer them for receiving those benefits which he is at all times ready to pour upon all mankind. In his essence God is equally present with the righteous and with the wicked, with those who pray, and with those who pray not; for "the eyes of the Lord are in every place beholding the evil and the good." But as the atmosphere equally surrounds every person upon this globe, and yet in its state of greatest purity does not affect the asthmatic as it affects those who are whole; so the Divine presence, though essentially the same everywhere, yet does not protect the impious as it protects the devout, because the impious are not in a state capable of the Divine protection. The end for which God requires the exercise of prayer as a duty, is not his benefit but ours; because it is a mean to generate in the petitioner such a disposition of mind as must render him a special object of that love and that providential care which extend over the whole creation.

That part of the objection which results from the consideration of the fixed laws of nature, and which the poet has so finely illustrated, presents, it must be confessed, considerable difficulties; but none which to us ap-

pear insurmountable. If, indeed, we suppose that in the original constitution of things, when the laws of nature were established, a determinate duration was given to the top of the mountain and the nodding temple, without any regard to foreseen consequences, it would undoubtedly be absurd and perhaps impious to expect the law of gravitation to be suspended by the prayers of a good man, who should happen to be passing at the instant decreed for the fall of these objects. But of such a constitution there is so far from being evidence, that it appears not to be consistent with the wisdom and goodness of the Author of nature. This world was undoubtedly formed for the habitation of man and of other animals. If so, we must necessarily suppose, that in the establishing of the laws of nature, God adjusted them in such a manner as he saw would best serve the accommodation of those sentient beings for whose accommodation alone they were to be established. Let it then be admitted, that all the human beings who were ever to exist upon this globe, with all their thoughts, words, and actions, were at that important moment present to the divine intellect, and it surely will not be impossible to conceive, that in consequence of the foreseen danger and prayers of a good man, the determinate duration of the mountain and the tower might be either lengthened or shortened to let him escape. This idea of providence, and of the efficacy of prayer, is thus illustrated by Mr. Wollaston *. "Suppose M (some man) certainly to *foreknow*, by some means or other, that, when he should come to be upon his death-bed, L would *petition* for some *particular legacy*, in a manner so earnest and humble, and with such a good disposition, as would render it proper to grant his request: and upon this, M makes his *last will*, by which he devises to L that which was to be asked, and then locks up the *will*; and all this many years before the death of M, and whilst L had yet no expectation or thought of any such thing. When the time comes, the *petition* is made and *granted*; not by making any *new will*, but by the old one already made, and without alteration: which legacy had, notwithstanding that, never been left, had the petition never been preferred. The grant may be called the effect of a future act, and depends as much upon it as if it had been made after the act. So, if it had been foreseen, that L would not *so much as ask*, and he had been therefore left out of the will, this *præterition* would have been caused by his carriage, though much later than the date of the will. In all this nothing is hard to be admitted, if M be allowed to foreknow the case. And thus the *prayers* which good men offer to the *all-knowing God*, and the *neglect of prayers* by others, may find fitting effects *already* forecasted in the course of nature."

This solution of the difficulty presents indeed to the mind a prodigious scheme, in which all things to come are, as it were, comprehended under one view, and estimated and compared together. But when it is considered what a mass of wonders the universe is in other respects; what an incomprehensibly great and perfect Being God is; that he cannot be ignorant of any thing, no not of the future wants and deportments of particular men; and that all things which derive their existence from him must be consistent with one another—it must surely be confessed that such an adjustment of physical causes to moral volitions is within the compass of infinite power and perfect wisdom.

To

Prayer.

* *Religion delineated.*

Prayer.

To that part of a prayer which we have termed intercession, it has been objected, that "to intercede for others is to presume that we possess an interest with the Deity upon which their happiness and even the prosperity of whole communities depends." In answer to this objection, it has been observed by an ingenious and useful writer †, that "how unequal soever our knowledge of the divine economy may be to a complete solution of this difficulty, which may require a comprehension of the entire plan, and of all the ends of God's moral government, to explain it satisfactorily, we can yet understand one thing concerning it, that it is, after all, nothing more than the making of one man the instrument of happiness and misery to another; which is perfectly of a piece with the course and order that obtain, and which we must believe were intended to obtain in human affairs. Why may we not be assisted by the prayers of other men, as well as we are beholden for our support to their labour? Why may not our happiness be made in some cases to depend upon the intercession as it certainly does in many upon the good offices of our neighbours? The happiness and misery of great numbers we see oftentimes at the disposal of one man's choice, or liable to be much affected by his conduct: what greater difficulty is there in supposing, that the prayers of an individual may avert a calamity from multitudes, or be accepted to the benefit of whole communities."

These observations may perhaps be sufficient to remove the force of the objection, but much more may be said for the practice of mutual intercession. If it be one man's duty to intercede for another, it is the duty of that other to intercede for him; and if we set aside the particular relations which arise from blood, and from particular stations in society, mutual intercession must be equally the duty of all mankind. But there is nothing (we speak from our own experience, and appeal to the experience of our readers) which has so powerful a tendency to generate in the heart of any person good-will towards another as the constant practice of praying to God for his happiness. Let a man regularly pray for his enemy with all that seriousness which devotion requires, and he will not long harbour resentment against him. Let him pray for his friend with that ardour which friendship naturally inspires, and he will perceive his attachment to grow daily and daily stronger. If, then, universal benevolence, or charity, be a disposition which we ought to cultivate in ourselves, mutual intercession is undeniably a duty, because nothing contributes so effectually to the acquisition of that spirit which an apostle terms the end of the commandment.

When it is said, that by interceding for kings, and all in authority, we seem to consider the prosperity of communities as depending upon our interest with God, the objector mistakes the nature and end of these intercessions. In the prosperity of any community consists great part of the happiness of its individual members; but that prosperity depends much upon the conduct of its governors. When, therefore, individuals intercede for their governors, the ultimate object of their prayers must be conceived to be their own good. As it is equally the duty of all the members of the community to pray for their governors, such intercessions are the prayers of the whole community for itself, and of every individual for himself. So that in this view of the case, the most just, we apprehend, that can be taken of it, it

is not true that supplications and intercessions for kings and all in authority are the prayers of one individual for another, but the prayers of many individuals for that body of which each of them knows himself to be a member.

Having evinced the duty of adoration, confession, supplication, and intercession, we need not surely waste our readers time with a formal and laboured vindication of thanksgiving. Gratitude for benefits received is so universally acknowledged to be a virtue, and ingratitude is so detestable a vice, that no man who lays claim to a moral character will dare to affirm that we ought not to have a just sense of the goodness of God in preserving us from the numberless dangers to which we are exposed, and "in giving us rain from heaven, and fruitful seasons, filling our hearts with food and gladness." But if we have this sense, whether we express it in words or not, we offer to God thanksgiving; because every movement of the heart is open and exposed to his all-seeing eye.

In this article we have treated of prayer in general, and as the private duty of every individual; but there ought to be *public* as well as *private* prayer, which shall be considered afterwards. (See WORSHIP.) We have likewise observed, that the prayers of every Christian ought to be offered in the name and through the mediation of Jesus Christ, for which the reason will be seen in the article THEOLOGY. We shall conclude our reflections on the general duty, with observing, that nothing so forcibly restrains from ill as the remembrance of a recent address to heaven for protection and assistance. After having petitioned for power to resist temptation, there is so great an incongruity in not continuing the struggle, that we blush at the thought, and persevere lest we lose all reverence for ourselves. After fervently devoting our souls to God, we start with horror at immediate apostasy: every act of deliberate wickedness is then complicated with hypocrisy and ingratitude: it is a mockery of the Father of Mercies, the forfeiture of that peace in which we closed our address, and a renunciation of the hope which that address inspired. But if prayer and immorality be thus incompatible, surely the former should not be neglected by those who contend that moral virtue is the summit of human perfection.

PREACHING. See DECLAMATION, Art. I.—The word is derived from the Hebrew *paraſch*, *expesuit*, "he expounded."

PREADAMITE, a denomination given to the inhabitants of the earth, conceived, by some people, to have lived before Adam.

Isaac de la Pereyra, in 1655, published a book to evince the reality of Preadamites, by which he gained a considerable number of proselytes to the opinion: but the answer of Demarets, professor of theology at Groningen, published the year following, put a stop to its progress; though Pereyra made a reply.

His system was this: The Jews he calls *Adamites*, and supposes them to have issued from Adam; and gives the title *Preadamites* to the Gentiles, whom he supposes to have been a long time before Adam. But this being expressly contrary to the first words of Genesis, Pereyra had recourse to the fabulous antiquities of the Egyptians and Chaldeans, and to some idle rabbins, who imagined there had been another world before that described

Prayer

||
Preada-
mite.† Mr Pa-
ley.

Preamble
||
Precept.

described by Moses. He was apprehended by the inquisition in Flanders, and very roughly used, though in the service of the dauphin. But he appealed from their sentence to Rome; whither he went in the time of Alexander VII. and where he printed a retraction of his book of Preadamites. See PRE-EXISTENCE.

PREAMBLE, in law, the beginning of an act of parliament, &c. which serves to open the intent of the act, and the mischiefs intended to be remedied by it.

PREBEND, the maintenance a prebendary receives out of the estate of a cathedral or collegiate church. Prebends are distinguished into simple and dignitary: a simple prebend has no more than the revenue for its support; but a prebend with dignity has always a jurisdiction annexed to it.

PREBENDARY, an ecclesiastic who enjoys a prebend.

The difference between a prebendary and a canon is, that the former receives his prebend in consideration of his officiating in the church, but the latter merely by his being received into the cathedral or college.

PRECARIUM, in Scots law. See LAW, N^o clxxiii.

PRECEDENCE, a place of honour to which a person is entitled. This is either of courtesy or of right. The former is that which is due to age, estate, &c. which is regulated by custom and civility: the latter is settled by authority; and when broken in upon, gives an action at law.

In Great Britain, the order of precedency is as follows: The king; the princes of the blood; the archbishop of Canterbury; the lord high chancellor; the archbishop of York; the lord treasurer of England; the lord president of the council; the lord privy seal; dukes; the eldest sons of dukes of the blood royal; marquisses; dukes eldest sons; earls; marquisses eldest sons; dukes younger sons; viscounts; earls eldest sons; marquisses younger sons; bishops; barons; speaker of the house of commons; lord commissioner of the great seal; viscounts eldest sons; earls younger sons; barons eldest sons; privy counsellors not peers; chancellor of the exchequer; chancellor of the duchy; knights of the garter not peers; lord chief justice of the king's bench; master of the rolls; lord chief justice of the common pleas; lord chief baron of the exchequer; puisne judges and barons; knights banneret, if made in the field; masters in chancery; viscounts younger sons; barons younger sons; baronets; knights banneret; knights of the Bath; knights bachelors; baronets eldest sons; knights eldest sons; baronets younger sons; knights younger sons; field and flag officers; doctors graduate; serjeants at law; esquires; gentlemen bearing coat armour; yeomen; tradesmen; artificers; labourers.—*Not.* The ladies, except those of archbishops, bishops, and judges, take place according to the degree of quality of their husbands; and unmarried ladies take place according to that of their fathers.

PRECEDENT, in law, a case which has been determined, and which serves as a rule for all of the same nature.

PRECENTOR, a dignity in cathedrals, popularly called the *chantor*, or *master of the choir*.

PRECEPT, in law, a command in writing sent by a chief justice or justice of the peace, for bringing a person, record, or other matter before him.

PRECEPT of *Clave Constat*, in Scots law. See LAW, Precept Part III. n^o clxxx. 28.

PRECEPT of *Seisin*, in Scots law. See LAW, Part III. Precession. n^o clxiv. 16.

PRECEPTIVE, any thing which gives or contains precepts.

PRECEPTIVE Poetry. See POETRY, n^o 146, &c.

PRECESSION OF THE EQUINOXES. The most obvious of all the celestial motions is the diurnal revolution of the starry heavens. The whole appears to turn round an imaginary axis, which passes through two opposite points of the heavens, called the *poles*. One of these is in our sight, being very near the star and in the tail of the little bear. The great circle which is equidistant from both poles divides the heavens into the northern and southern hemispheres, which are equal. It is called the *equator*, and it cuts the horizon in the east and west points, and every star in it is 12 sidereal hours above and as many below the horizon, in each revolution.

The sun's motions determine the length of day and night, and the vicissitudes of the seasons. By a long series of observations, the shepherds of Asia were able to mark out the sun's path in the heavens; he being always in the opposite point to that which comes to the meridian at midnight, with equal but opposite declination. Thus they could tell the stars among which the sun then was, although they could not see them. They discovered that his path was a great circle of the heavens, afterward called the *ECLIPSE*; which cuts the Equator in two opposite points, dividing it, and being divided by it, into two equal parts. They farther observed, that when the sun was in either of these points of intersection, his circle of diurnal revolution coincided with the equator, and therefore the days and nights were equal. Hence the equator came to be called the *EQUINOCTIAL LINE*, and the points in which it cuts the ecliptic were called the *EQUINOCTIAL POINTS*, and the sun was then said to be in the equinoxes. One of these was called the *VERNAL* and the other the *AUTUMNAL EQUINOX*.

It was evidently an important problem in practical astronomy to determine the exact moment of the sun's occupying these stations; for it was natural to compute the course of the year from that moment. Accordingly this has been the leading problem in the astronomy of all nations. It is susceptible of considerable precision, without any apparatus of instruments. It is only necessary to observe the sun's declination on the noon of two or three days before and after the equinoctial day. On two consecutive days of this number, his declination must have changed from north to south, or from south to north. If his declination on one day was observed to be 21' north, and on the next 5' south, it follows that his declination was nothing, or that he was in the equinoctial point about 23 minutes after 7 in the morning of the second day. Knowing the precise moments, and knowing the rate of the sun's motion in the ecliptic, it is easy to ascertain the precise point of the ecliptic in which the equator intersected it.

By a series of such observations made at Alexandria between the years 161 and 127 before Christ, Hipparchus the father of our astronomy found that the point of the autumnal equinox was about six degrees to the eastward of the star called *SPICA VIRGINIS*. Eager to determine

Precession. determine everything by multiplied observations, he ransacked all the Chaldean, Egyptian, and other records, to which his travels could procure him access, for observations of the same kind; but he does not mention his having found any. He found, however, some observations of Aristillus and Timochares made about 150 years before. From these it appeared evident that the point of the autumnal equinox was then about eight degrees east of the same star. He discusses these observations with great sagacity and rigour; and, on their authority, he asserts that the equinoctial points are not fixed in the heavens, but move to the westward about a degree in 75 years or somewhat less.

5
Why called the precession of the equinoxes.

This motion is called the PRECESSION OF THE EQUINOXES, because by it the time and place of the sun's equinoctial station precedes the usual calculations: it is fully confirmed by all subsequent observations. In 1750 the autumnal equinox was observed to be $20^{\circ} 21'$ westward of spica virginis. Supposing the motion to have been uniform during this period of ages, it follows that the annual precession is about $50''\frac{1}{2}$; that is, if the celestial equator cuts the ecliptic in a particular point on any day of this year, it will on the same day of the following year cut it in a point $50''\frac{1}{2}$ to the west of it, and the sun will come to the equinox $20' 23''$ before he has completed his round of the heavens. Thus the equinoctial or tropical year, or true year of seasons, is so much shorter than the revolution of the sun or the sidereal year.

6
Importance of the discovery.

It is this discovery that has chiefly immortalized the name of Hipparchus, though it must be acknowledged that all his astronomical researches have been conducted with the same sagacity and intelligence. It was natural therefore for him to value himself highly for the discovery. It must be acknowledged to be one of the most singular that has been made, that the revolution of the whole heavens should not be stable, but its axis continually changing. For it must be observed, that since the equator changes its position, and the equator is only an imaginary circle, equidistant from the two poles or extremities of the axis; these poles and this axis must equally change their positions. The equinoctial points make a complete revolution in about 25745, the equator being all the while inclined to the ecliptic in nearly the same angle. Therefore the poles of this diurnal revolution must describe a circle round the poles of the ecliptic at the distance of about $23\frac{1}{2}^{\circ}$ degrees in 25745 years; and in the time of Timochares the north pole of the heavens must have been 30 degrees eastward of where it now is.

7
Hipparchus has been accused of plagiarism.

Hipparchus has been accused of plagiarism and insincerity in this matter. It is now very certain that the precession of the equinoxes was known to the astronomers of India many ages before the time of Hipparchus. It appears also that the Chaldeans had a pretty accurate knowledge of the year of seasons. From their saros we deduce their measure of this year to be 365 days 5 hours 49 minutes and 11 seconds, exceeding the truth only by 26'', and much more exact than the year of Hipparchus. They had also a sidereal year of 365 days 6 hours 11 minutes. Now what could occasion an attention to two years, if they did not suppose the equinoxes moveable? The Egyptians also had a knowledge of something equivalent to this: for they had discovered that the dog-star was no longer the faithful forwarner of the overflowing of the Nile; and they com-

bined him with the star Fomalhasset* in their mystical Precession. kalendar. This knowledge is also involved in the precepts of the Chinese astronomy, of much older date than the time of Hipparchus.

* See Dupins sur le zodiaque

But all these acknowledged facts are not sufficient for depriving Hipparchus of the honour of the discovery, or fixing on him the charge of plagiarism. This motion was a thing unknown to the astronomers of the Alexandrian school, and it was pointed out to them by Hipparchus in the way in which he ascertained every other position in astronomy, namely, as the mathematical result of actual observations, and not as a thing deducible from any opinions on other subjects related to it. We see him, on all other occasions, eager to confirm his own observations, and his deductions from them, by every thing he could pick up from other astronomers; and he even adduced the above-mentioned practice of the Egyptians in corroboration of his doctrine. It is more than probable then that he did not know any thing more. Had he known the Indian precession of $54''$ annually, he had no temptation whatever to withhold him from using it in preference to one which he acknowledges to be inaccurate, because deduced from the very short period of 150 years, and from the observations of Timochares, in which he had no great confidence.

This motion of the starry heavens was long a matter of discussion, as a thing for which no physical reason could be assigned. But the establishment of the Copernican system reduced it to a very simple affair; the motion which was thought to affect all the heavenly bodies, is now acknowledged to be a deception, or a false judgment from the appearances. The earth turns round its own axis while it revolves round the sun, in the same manner as we may cause a child's top to spin on the brim of a mill-stone, while the stone is turning slowly round its axis. If the top spin steadily, without any wavering, its axis will always point to the zenith of the heavens; but we frequently see, that while it spins briskly round its axis, the axis itself has a slow conical motion round the vertical line, so that, if produced, it would slowly describe a circle in the heavens round the zenith point. The flat surface of the top may represent the terrestrial equator, gradually turning itself round on all sides. If this top were formed like a ball, with an equatorial circle on it, it would represent the whole motion very prettily, the only difference being, that the spinning motion and this wavering motion are in the same direction; whereas the diurnal rotation and the motion of the equinoctial points are in contrary directions. Even this dissimilarity may be removed, by making the top turn on a cap, like the card of a mariner's compass.

It is now a matter fully established, that while the earth revolves round the sun from west to east, in the plane of the ecliptic, in the course of a year it turns round its own axis from west to east in $23^{\circ} 56' 4''$, which axis is inclined to this plane in an angle of nearly $23^{\circ} 28'$; and that this axis turns round a line perpendicular to the ecliptic in 25,745 years from east to west, keeping nearly the same inclination to the ecliptic.—By this means, its pole in the sphere of the starry heavens describes a circle round the pole of the ecliptic at the distance of $23^{\circ} 28'$ nearly. The consequence of this must be, that the terrestrial equator, when produced

des Egyptiens, Mem. de l'Acad. des Inscript.

But falsely,

9
Heavenly motions accounted for by the Copernican system,

10
And the earth's.

Precession ced to the sphere of the starry heavens, will cut the ecliptic in two opposite points, through which the sun must pass when he makes the day and night equal; and that these points must shift to the westward, at the rate of $50\frac{1}{2}$ seconds annually, which is the precession of the equinoxes. Accordingly this has been the received doctrine among astronomers for nearly three centuries, and it was thought perfectly conformable to appearances.

11
Bradley's attempt to discover the parallax of the earth's orbit.

But Dr Bradley, the most sagacious of modern astronomers, hoped to discover the parallax of the earth's orbit by observations of the actual position of the pole of the celestial revolution. Dr Hooke had attempted this before, but with very imperfect instruments. The art of observing being now prodigiously improved, Dr Bradley resumed this investigation. It will easily appear, that if the earth's axis keeps parallel to itself, its extremity must describe in the sphere of the starry heavens a figure equal and parallel to its orbit round the sun; and if the stars be so near that this figure is a visible object, the pole of diurnal revolution will be in different distinguishable points of this figure. Consequently, if the axis describes the cone already mentioned, the pole will not describe a circle round the pole of the ecliptic, but will have a looped motion along this circumference, similar to the absolute motion of one of Jupiter's satellites, describing an epicycle whose centre describes the circle round the pole of the ecliptic.

12
Difficulties in the attempt obviated by accident.

He accordingly observed such an epicyclical motion, and thought that he had now overcome the only difficulty in the Copernican system; but, on maturely considering his observations, he found this epicycle to be quite inconsistent with the consequences of the annual parallax, and it puzzled him exceedingly. One day, while taking the amusement of sailing about on the Thames, he observed, that every time the boat tacked, the direction of the wind, estimated by the direction of the vane, seemed to change. This immediately suggested to him the cause of his observed epicycle, and he found it an optical illusion, occasioned by a combination of the motion of light with the motion of his telescope while observing the polar stars. Thus he unwittingly established an incontrovertible argument for the truth of the Copernican system, and immortalized his name by his discovery of the **ABERRATION** of the stars.

13
His further investigation of the subject.

He now engaged in a series of observations for ascertaining all the circumstances of this discovery. In the course of these, which were continued for 28 years, he discovered another epicyclical motion of the pole of the heavens, which was equally curious and unexpected. He found that the pole described an epicycle, whose diameter was about $18''$, having for its centre that point of the circle round the pole of the ecliptic in which the pole would have been found independent of this new motion. He also observed, that the period of this epicyclical motion was 18 years and seven months. It struck him, that this was precisely the period of the revolution of the nodes of the moon's orbit. He gave a brief account of these results to Lord Macclesfield, then president of the Royal Society, in 1747. Mr Machin, to whom he also communicated the observations, gave him in return a very neat mathematical hypothesis, by which the motion might be calculated.

Plate
CCCCXIV

Let E (fig. 1.), be the pole of the ecliptic, and SPQ
VOL. XV. Part II.

a circle distant from it $23^{\circ} 28'$, representing the circle described by the pole of the equator during one revolution of the equinoctial points. Let P be the place of this last mentioned pole at some given time. Round P describe a circle ABCD, whose diameter AC is $18''$. The real situation of the pole will be in the circumference of this circle; and its place, in this circumference, depends on the place of the moon's ascending node. Draw EPF and GPL perpendicular to it; let GL be the colure of the equinoxes, and EF the colure of the solstices. Dr Bradley's observations showed that the pole was in A when the node was in L, the vernal equinox. If the node recede to H, the winter solstice, the pole is in B. When the node is in the autumnal equinox at G, the pole is at C; and when the node is in F, the summer solstice, the pole is in D. In all intermediate situations of the moon's ascending node, the pole is in a point of the circumference ABCD, three signs or 90° more advanced.

Dr Bradley, by comparing together a great number of observations, found that the mathematical theory, and the calculation depending on it, would correspond much better with the observations, if an ellipse were substituted for the circle ABCD, making the longer axis AC $18''$, and the shorter, BD, $16''$. Mr d'Alembert determined, by the physical theory of gravitation, the axes to be $18''$ and $13''$. 4.

These observations, and this mathematical theory, must be considered as so many facts in astronomy, and we must deduce from them the methods of computing the places of all celestial phenomena, agreeable to the universal practice of determining every point of the heavens by its longitude, latitude, right ascension, and declination.

It is evident, in the first place, that this equation of the pole's motion makes a change in the obliquity of the ecliptic. The inclination of the equator to the ecliptic is measured by the arch of a great circle intercepted between their poles. Now, if the pole be in O instead of P, it is plain that the obliquity is measured by EO instead of EP. If EP be considered as the mean obliquity of the ecliptic, it is augmented by $9''$ when the moon's ascending node is in the vernal equinox, and consequently the pole in A. It is, on the contrary, diminished $9''$ when the node is in the autumnal equinox, and the pole in C; and it is equal to the mean when the node is in the colure of the solstices. This change of the inclination of the earth's axis to the plane of the ecliptic was called the **NUTATION** of the axis by Sir Isaac Newton; who showed, that a change of nearly a second must obtain in a year by the action of the sun on the prominent parts of the terrestrial spheroid. But he did not attend to the change which would be made in this motion by the variation which obtains in the disturbing force of the moon, in consequence of the different obliquity of her action on the equator, arising from the motion of her own oblique orbit. It is this change which now goes by the name **NUTATION**, and we owe its discovery entirely to Dr Bradley. The general change of the position of the earth's axis has been termed **DEVIATION** by modern astronomers.

The quantity of this change of obliquity is easily ascertained. It is evident, from what has been already said, that when the pole is in O, the arch ADCO is equal

Precession. equal to the node's longitude from the vernal equinox, and that PM is its cosine; and (on account of the smallness of AP in comparison of EP) PM may be taken for the change of the obliquity of the ecliptic. This is therefore $= 9'' \times \cos. \text{node}$, and is additive to the mean obliquity, while O is in the semicircle BAD, that is, while the longitude of the node is from 9 signs to 3 signs; but subtractive while the longitude of the node changes from 3 to 9 signs.

19
Change of
the equi-
noctial
points.

But the nutation changes also the longitudes and right ascensions of the stars and planets by changing the equinoctial points, and thus occasioning an equation in the precession of the equinoctial points. It was this circumstance which made it necessary for us to consider it in this place, while expressly treating of this precession. Let us attend to this derangement of the equinoctial points.

20
Situation
of the sol-
stitial and
equinoctial
colures.

The great circle or meridian which passes through the poles of the ecliptic and equator is always the solstitial colure, and the equinoctial colure is at right angles to it: therefore when the pole is in P or in O, EP or EO is the solstitial colure. Let S be any fixed star or planet, and let SE be a meridian or circle of longitude; draw the circles of declination PS, OS, and the circles M'EM', mEm', perpendicular to PE, OE.

21
Equation
of longi-
tude from
nutation of
the earth's
axis.

If the pole were in its mean place P, the equinoctial points would be in the ecliptic meridian M'EM', or that meridian would pass through the intersections of the equator and ecliptic, and the angle MES would measure the longitude of the star S. But when the pole is in O, the ecliptic meridian mEm' will pass through the equinoctial points. The equinoctial points must therefore be to the westward of their mean place, and the equation of the precession must be additive to that precession; and the longitude of the star S will now be measured by the angle mES, which, in the case here represented, is greater than its mean longitude. The difference, or the equation of longitude, arising from the

nutation of the earth's axis, is the angle OEP, or $\frac{OM}{OE}$. OM is the sine of the angle CPO, which, by what has been already observed, is equal to the longitude of the node: Therefore OM is equal to $9'' \times \text{long. node}$, and $\frac{OM}{OE}$ is equal to $\frac{9'' \times \text{fin. long. node}}{\text{fin. obl. eclip.}}$. This equation is

additive to the mean longitude of the star when O is in the semicircle CBA, or while the ascending node is passing backwards from the vernal to the autumnal equinox; but it is subtractive from it while O is in the semicircle ADC, or while the node is passing backwards from the autumnal to the vernal equinox; or, to express it more briefly, the equation is subtractive from the mean longitude of the star, while the ascending node is in the first six signs, and additive to it while the node is in the last six signs.

This equation of longitude is the same for all the stars, for their longitude is reckoned on the ecliptic (which is here supposed invariable); and therefore is affected only by the variation of the point from which the longitude is computed.

22
Right
ascension
suffers a
double
change.

The right ascension, being computed on the equator, suffers a double change. It is computed from, or begins at, a different point of the equator, and it terminates at a different; point because the equator having

changed its position, the circles of declination also change theirs. When the pole is at P, the right ascension of S from the solstitial colure is measured by the angle SPE, contained between that colure and the star's circle of declination. But when the pole is at O, the right ascension is measured by the angle SOE, and the difference of SPE and SOE is the equation of right ascension. The angle SOE consists of two parts, GOE and GOS; GOE remains the same wherever the star S is placed, but GOS varies with the place of the star.— We must first find the variation by which GPE becomes GOE, which variation is common to all the stars. The triangles GPE, GOE, have a constant side GE, and a constant angle G; the variation PO of the side GP is extremely small, and therefore the variation of the angles may be computed by Mr Cotes's Fluxionary Theorems. See Simpson's *Fluxions*, § 253, &c. As the tangent of the side EP, opposite to the constant angle G, is to the sine of the angle EPG, opposite to the constant side EG, so is PO the variation of the side GP, adjacent to the constant angle, to the variation x of the angle GPO, opposite to the constant side EG. This gives

$$x = \frac{9'' \times \text{fin. long. node}}{\text{tang. obl. eclip.}}$$

This is subtractive from the mean right ascension for the first six signs of the node's longitude, and additive for the last six signs. This equation is common to all the stars.

The variation of the other part SOG of the angle, which depends on the different position of the hour circles PS and OS, which causes them to cut the equation in different points, where the arches of right ascension terminate, may be discovered as follows. The triangles SPG, SOG, have a constant side SG, and a constant angle G. Therefore, by the same Cotesian theorem, $\tan. SP : \text{fin. SPG} = PO : y$, and y, or the second part of the nutation in right ascension, = $9'' \times \text{fin. diff. R. A. of star and node}$

$\frac{\text{cotan. declin. star}}{\text{fin. obl. eclip.}}$

The nutation also affects the declination of the stars: For SP, the mean codeclination, is changed into SO.— Suppose a circle described round S, with the distance SO cutting SP in f; then it is evident that the equation of declin. is $Pf = PO \times \cosine OPf = 9'' \times \text{fin. r. ascen. of star} - \text{long. of node}$.

Such are the calculations in constant use in our astronomical researches, founded on Machin's Theory. When still greater accuracy is required, the elliptical theory must be substituted, by taking (as is expressed by the dotted lines) O in that point of the ellipse described on the transverse axis AC, where it is cut by OM, drawn according to Machin's theory. All the change made here is the diminution of OM in the ratio of 18 to 13,4, and a corresponding diminution of the angle CPO. The detail of it may be seen in De la Lande's *Astronomy*, art. 2874; but is rather foreign to our present purpose of explaining the precession of the equinoxes. The calculations being in every case tedious, and liable to mistakes, on account of the changes of the signs of the different equations, the zealous promoters of astronomy have calculated and published tables of all these equations, both on the circular and elliptical hypothesis. And still more to abridge calculations, which occur in reducing every astronomical observation, when the place of a phenomenon is deduced from a comparison

23
Other va-
riations,
&c.

24
Nutation
affects the
declinations
of the stars.

25
A more
exact mode
of calcula-
tion.

Precession. for with known fixed stars, there have been published tables of nutation and precession, for some hundreds of the principal stars, for every position of the moon's node and of the sun.

²⁶
Precession of the equinoctial points, &c. It now remains to consider the precession of the equinoctial points, with its equations, arising from the nutation of the earth's axis as a physical phenomenon, and to endeavour to account for it upon those mechanical principles which have so happily explained all the other phenomena of the celestial motions.

²⁷
Observations of Newton and others on this subject. This did not escape the penetrating eye of Sir Isaac Newton; and he quickly found it to be a consequence, and the most beautiful proof, of the universal gravitation of all matter to all matter; and there is no part of his immortal work where his sagacity and fertility of resource shine more conspicuously than in this investigation. It must be acknowledged, however, that Newton's investigation is only a shrewd guess, founded on assumptions, of which it would be extremely difficult to demonstrate either the truth or falsity, and which required the genius of a Newton to pick out in such a complication of abstruse circumstances. The subject has occupied the attention of the first mathematicians of Europe since his time; and is still considered as the most curious and difficult of all mechanical problems. The most elaborate and accurate dissertations on the precession of the equinoxes are those of Sylvabella and Walmesly, in the Philosophical Transactions, published about the year 1754; that of Thomas Simpson, published in his Miscellaneous Tracts; that of Father Frisius, in the Memoirs of the Berlin Academy, and afterwards, with great improvements, in his Cosmographia; that of Euler in the Memoirs of Berlin; that of D'Alembert in a separate dissertation; and that of De la Grange on the Libration of the Moon, which obtained the prize in the Academy of Paris in 1769. We think the dissertation of Father Frisius the most perspicuous of them all, being conducted in the method of geometrical analysis; whereas most of the others proceed in the fluxionary and symbolic method, which is frequently deficient in distinct notions of the quantities under consideration, and therefore does not give us the same perspicuous conviction of the truth of the results. In a work like ours, it is impossible to do justice to the problem, without entering into a detail which would be thought extremely disproportioned to the subject by the generality of our readers. Yet those who have the necessary preparation of mathematical knowledge, and wish to understand the subject fully, will find enough here to give them a very distinct notion of it; and in the article **ROTATION**, they will find the fundamental theorems, which will enable them to carry on the investigation. We shall first give a short sketch of Newton's investigation, which is of the most palpable and popular kind, and is highly valuable, not only for its ingenuity, but also because it will give our unlearned readers distinct and satisfactory conceptions of the chief circumstances of the whole phenomena.

²⁸
Sketch of Newton's investigation of it. Let S (fig. 2.) be the sun, E the Earth, and M the Moon, moving in the orbit NMCD_n, which cuts the plane of the Ecliptic in the line of the nodes N_n, and has one half raised above it, as represented in the figure, the other half being hid below the Ecliptic. Suppose this orbit folded down; it will coincide with the Ecliptic in the circle N m c d n. Let EX represent the

axis of this orbit, perpendicular to its plane, and therefore inclined to the Ecliptic. Since the Moon gravitates to the sun in the direction MS, which is all above the Ecliptic, it is plain that this gravitation has a tendency to draw the Moon towards the Ecliptic. Suppose this force to be such that it would draw the Moon down from M to *i* in the time that she would have moved from M to *t*, in the tangent to her orbit. By the combination of these motions, the Moon will desert her orbit, and describe the line Mr, which makes the diagonal of the parallelogram; and if no farther action of the sun be supposed, she will describe another orbit M^sn', lying between the orbit MCD_n and the Ecliptic, and she will come to the Ecliptic, and pass through it in a point *n'*, nearer to M than *n* is, which was the former place of her descending node. By this change of orbit, the line EX will no longer be perpendicular to it; but there will be another line Ex, which will now be perpendicular to the new orbit. Also the Moon, moving from M to *r*, does not move as if she had come from the ascending node N, but from a point N' lying beyond it; and the line of the nodes of the orbit in this new position is N' n'. Also the angle MN^m is less than the angle MN^m.

Thus the nodes shift their places in a direction opposite to that of her motion, or move to the westward; the axis of the orbit changes its position, and the orbit itself changes its inclination to the ecliptic. These momentary changes are different in different parts of the orbit, according to the position of the line of the nodes. Sometimes the inclination of the orbit is increased, and sometimes the nodes move to the eastward. But, in general, the inclination increases from the time that the nodes are in the line of syzygy, till they get into quadrature, after which it diminishes till the nodes are again in syzygy. The nodes advance only while they are in the octants after the quadratures, and while the moon passes from quadrature to the node, and they recede in all other situations. Therefore the recess exceeds the advance in every revolution of the moon round the earth, and, on the whole, they recede.

What has been said of one Moon, would be true of each of a continued ring of Moons surrounding the Earth, and they would thus compose a flexible ring, which would never be flat, but waved, according to the difference (both in kind and degree) of the disturbing forces acting on its different parts. But suppose these Moons to cohere, and to form a rigid and flat ring, nothing would remain in this ring but the excess of the contrary tendencies of its different parts. Its axis would be perpendicular to its plane, and its position in any moment will be the mean position of all the axes of the orbits of each part of the flexible ring; therefore the nodes of this rigid ring will continually recede, except when the plane of the ring passes through the Sun, that is, when the nodes are in syzygy; and (says Newton) the motion of these nodes will be the same with the mean motion of the nodes of the orbit of one Moon. The inclination of this ring to the ecliptic will be equal to the mean inclination of the Moon's orbit during any one revolution which has the same situation of the nodes. It will therefore be least of all when the nodes are in quadrature, and will increase till they are in syzygy, and then diminish till they are again in quadrature.

Suppose this ring to contract in dimensions, the dis-

Precession. disturbing forces will diminish in the same proportion, and in this proportion will all their effects diminish. Suppose its motion of revolution to accelerate, or the time of a revolution to diminish; the linear effects of the disturbing forces being as the squares of the times of their action, and their angular effects as the times, those errors must diminish also on this account; and we can compute what those errors will be for any diameter of the ring, and for any period of its revolution. We can tell, therefore, what would be the motion of the nodes, the change of inclination, and deviation of the axis, of a ring which would touch the surface of the earth, and revolve in 24 hours; nay, we can tell what these motions would be, should this ring adhere to the earth. They must be much less than if the ring were detached; For the disturbing forces of the ring must drag along with it the whole globe of the earth. The quantity of motion which the disturbing forces would have produced in the ring alone, will now (says Newton) be produced in the whole mass; and therefore the velocity must be as much less as the quantity of matter is greater: But still all this can be computed.

Now there is such a ring on the earth: for the earth is not a sphere, but an elliptical spheroid. Sir Isaac Newton therefore engaged in a computation of the effects of the disturbing force, and has exhibited a most beautiful example of mathematical investigation. He first asserts, that the earth *must* be an elliptical spheroid, whose polar axis is to its equatorial diameter as 229 to 230. Then he demonstrates, that if the sine of the inclination of the equator be called π , and if t be the number of days (sidereal) in a year, the annual motion of

a detached ring will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{4t}$. He then shows that the effect of the disturbing force on this ring is to its effect on the matter of the same ring, distributed in the form of an elliptical stratum (but still detached) as 5 to 2; therefore the motion of the nodes will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{10t}$, or $16' 16'' 24'''$ annually. He

then proceeds to show, that the quantity of motion in the sphere is to that in an equatorial ring revolving in the same time, as the matter in the sphere to the matter in the ring, and as three times the square of a quadrantal arch to two squares of a diameter, jointly: Then he shows, that the quantity of matter in the terrestrial sphere is to that in the protuberant matter of the spheroid, as 52900 to 461 (supposing all homogeneous). From these premises it follows, that the motion of $16' 16'' 24'''$, must be diminished in the ratio of 10717 to 100, which reduces it to $9'' 07'''$ annually. And this (he says) is the precession of the equinoxes, occasioned by the action of the sun; and the rest of the $50\frac{1}{2}''$, which is the observed precession, is owing to the action of the moon, nearly five times greater than that of the sun. This appeared a great difficulty: for the phenomena of the tides show that it *cannot* much exceed twice the sun's force.

29. His determination of the form and dimensions of the earth demonstrated by M^r Laurin.

Nothing can exceed the ingenuity of this process. Justly does his celebrated and candid commentator, Daniel Bernoulli, say (in his Dissertation on the Tides, which shared the prize of the French Academy with M^r Laurin and Euler), that Newton saw through a veil

Precession. what others could hardly discover with a microscope in the light of the meridian sun. His determination of the form and dimensions of the earth, which is the foundation of the whole process, is not offered as any thing better than a probable guess, *in re difficillima*; and it has been since demonstrated with geometrical rigour by M^r Laurin.

His next principle, that the motion of the nodes of the rigid ring is equal to the mean motion of the nodes of the moon, has been most critically discussed by the first mathematicians, as a thing which could neither be proved nor refuted. Frisius has at least shown it to be a mistake, and that the motion of the nodes of the ring is double the mean motion of the nodes of a single moon; and that Newton's own principles should have produced a precession of $18\frac{1}{2}$ seconds annually, which removes the difficulty formerly mentioned.

His third assumption, that the quantity of motion of the ring must be shared with the included sphere, was acquiesced in by all his commentators, till D'Alembert and Euler, in 1749, showed that it was not the quantity of motion round an axis of rotation which remained the same, but the quantity of momentum or rotatory effort. The quantity of motion is the product of every particle by its velocity; that is, by its distance from the axis; while its momentum, or power of producing rotation, is as the square of that distance, and is to be had by taking the sum of each particle multiplied by the square of its distance from the axis. Since the earth differs so little from a perfect sphere, this makes no sensible difference in the result. It will increase Newton's precession about three-fourths of a second.

We proceed now to the examination of this phenomenon upon the fundamental principles of mechanics. Because the mutual gravitation of the particles of matter in the solar system is in the inverse ratio of the squares of the distance, it follows, that the gravitations of the different parts of the earth to the sun or to the moon are unequal. The nearer particles gravitate more than those that are more remote.

Let PQpE (fig. 3.), be a meridional section of the terrestrial sphere, and POpq the section of the inscribed sphere. Let CS be a line in the plane of the ecliptic passing through the sun, so that the angle ECS is the sun's declination. Let NCM be a plane passing thro' the centre of the earth at right angles to the plane of the meridian PQpE; NCM will therefore be the plane of illumination.

In consequence of the unequal gravitation of the matter of the earth to the sun, every particle, such as B, is acted on by a disturbing force parallel to CS, and proportional to BD, the distance of the particle from the plane of illumination; and this force is to the gravitation of the central particle to the sun, as three times BD is to CS, the distance of the earth from the sun.

Let ABa be a plane passing through the particle B, parallel to the plane EQ of the equator. This section of the earth will be a circle, of which Aa is a diameter, and Qq will be the diameter of its section with the inscribed sphere. These will be two concentric circles, and the ring by which the section of the spheroid exceeds the section of the sphere will have AQ for its breadth; Pp is the axis of figure.

Let

Precession.

30. Examination of the phenomenon of precession on mechanical principles.

Plate CCCCXIV

Precession.

Let EC be represented by the symbol	-	a
OC or PC	-	b
EO their difference, $= \frac{a^2 - b^2}{a + b}$	-	d
CL	-	x
QL	-	$\sqrt{b^2 - x^2}$
The periphery of a circle to radius 1	-	π
The disturbing force at the distance 1 from the plane NCM	-	f
The sine of declination ECS	-	m
The cosine of ECS	-	n

It is evident, that with respect to the inscribed sphere, the disturbing forces are completely compensated, for every particle has a corresponding particle in the adjoining quadrant, which is acted on by an equal and opposite force. But this is not the case with the protuberant matter which makes up the spheroid. The segments NSn and MTm are more acted on than the segments NTn and MSm ; and thus there is produced a tendency to a conversion of the whole earth, round an axis passing through the centre C, perpendicular to the plane $PQPE$. We shall distinguish this motion from all others to which the spheroid may be subject, by the name LIBRATION. The axis of this libration is always perpendicular to that diameter of the equator over which the sun is, or to that meridian in which he is.

PROB. I. To determine the momentum of libration corresponding to any position of the earth respecting the sun, that is, to determine the accumulated energy of the disturbing forces on all the protuberant matter of the spheroid.

Let B and b be two particles in the ring formed by the revolution of AQ, and so situated, that they are at equal distances from the plane NM; but on opposite sides of it. Draw BD, bd, perpendicular to NM, and FLG perpendicular to LT.

Then, because the momentum, or power of producing rotation, is as the force and as the distance of its line of direction from the axis of rotation, jointly, the combined momentum of the particles B and b will be $f \cdot BD \cdot DC - f \cdot bd \cdot dc$, (for the particles B and b, are urged in contrary directions). But the momentum of B is $f \cdot BF \cdot DC + f \cdot FD \cdot DC$, and that of b is $f \cdot bG \cdot dC - f \cdot dG \cdot dC$; and the combined momentum is $f \cdot BF \cdot DC - f \cdot FD \cdot DC + dC = 2f \cdot BF \cdot LF - 2f \cdot LT \cdot TC$.

Because m and n are the sine and cosine of the angle ECS or LCT, we have $LT = m \cdot CL$, and $CT = n \cdot CL$, and $LF = m \cdot BL$, and $BF = n \cdot BL$. This gives the momentum $= 2fmn \cdot BL^2 - CL^2$.

The breadth AQ of the protuberant ring being very small, we may suppose, without any sensible error, that all the matter of the line AQ is collected in the point Q; and, in like manner, that the matter of the whole ring is collected in the circumference of its inner circle, and that B and b now represent, not single particles, but the collected matter of lines such as AQ, which terminate at B and b. The combined momentum of two such lines will therefore be $2mnf \cdot AQ \cdot BL^2 - CL^2$.

Let the circumference of each parallel of latitude be divided into a great number of indefinitely small and equal parts. The number of such parts in the circumference, of which Qq is the diameter, will be $\pi \cdot QL$. To each pair of these there belongs a momentum $2mnf \cdot AQ \cdot BL^2 - CL^2$. The sum of all the squares of BL,

which can be taken round the circle, is one half of as many squares of the radius CL: for BL is the sine of an arch, and the sum of its square and the square of its corresponding cosine is equal to the square of the radius. Therefore the sum of all the squares of the sines, together with the sum of all the squares of the cosines, is equal to the sum of the same number of squares of the radius; and the sum of the squares of the sines is equal to the sum of the squares of the corresponding cosines: therefore the sum of the squares of the radius is double of either sum. Therefore $\sum \pi \cdot QL \cdot BL^2 = \frac{1}{2} \pi \cdot QL \cdot CL^2$. In like manner the sum of the number $\pi \cdot QL$ of CL^2 will be $= \pi \cdot QL \cdot CL^2$. These sums, taken for the semicircle, are $\frac{1}{4} \pi \cdot QL \cdot QL^2$, and $\frac{1}{2} \pi \cdot QL \cdot CL^2$, or $\pi \cdot QL \cdot \frac{1}{4} QL^2$, and $\pi \cdot QL \cdot \frac{1}{2} CL^2$: therefore the momentum of the whole ring will be $2mnf \cdot AQ \cdot QL \cdot (\frac{1}{4} QL^2 - \frac{1}{2} CL^2)$: for the momentum of the ring is the combined momenta of a number of pairs, and thus number is $\frac{1}{2} \pi \cdot QL$.

By the ellipse we have $OC : QL = EO : AQ$, and $AQ = QL \frac{EO}{OC} = QL \frac{d}{b}$; therefore the momentum of

the ring is $2mnf \frac{d}{b} QL^2 \pi (\frac{1}{4} QL^2 - \frac{1}{2} CL^2) = mnf \frac{d}{b} QL^2 \pi (\frac{1}{4} QL^2 - CL^2)$: but $QL^2 = b^2 - x^2$; therefore $\frac{1}{2} QL^2 - CL^2 = \frac{1}{2} b^2 - \frac{1}{2} x^2 - x^2 = \frac{1}{2} b^2 - \frac{3}{2} x^2 = \frac{b^2 - 3x^2}{2}$;

therefore the momentum of the ring is $mnf \frac{d}{b} \pi (b^2 - x^2) (\frac{b^2 - 3x^2}{2}) = mnf \frac{d}{b} \pi (\frac{b^4 - 4b^2x^2 + 3x^4}{2}) = mnf \frac{d}{2b} \pi (b^4 - 4b^2x^2 + 3x^4)$. If we now suppose another parallel extremely near to Aa, as represented by the dotted line, the distance L' between them being x , we shall have the fluxion of the momentum of the spheroid

$mnf \frac{d}{2b} \pi (b^4x - 4b^2x^3 + 3x^4x)$, of which the fluent is

$mnf \frac{d}{2b} \pi (\frac{b^4x^2}{2} - 4b^2 \frac{x^4}{4} + 3 \frac{x^5}{5})$. This expresses the momentum of the zone EAaQ, contained between the equator and the parallel of latitude Aa. Now let x become = b, and we shall obtain the momentum of the hemispheroid $= mnf \frac{d}{2b} \pi (b^5 - \frac{4}{3}b^5 + \frac{3}{5}b^5)$, and that of

the spheroid $= mnf \frac{d}{b} \pi (b^5 - \frac{4}{3}b^5 + \frac{3}{5}b^5) = \frac{4}{15} mnf d \pi b^4$.

This formula does not express any motion, but only a pressure tending to produce motion, and particularly tending to produce a libration by its action on the cohering matter of the earth, which is affected as a number of levers. It is similar to the common mechanical formula $w \cdot d$, where w means a weight, and d its distance from the fulcrum of the lever.

It is worthy of remark, that the momentum of this protuberant matter is just $\frac{1}{15}$ of what it would be if it were all collected at the point O of the equator: for the matter in the spheroid is to that in the inscribed sphere as a^2 to b^2 , and the contents of the inscribed sphere is $\frac{4}{3} \pi b^3$. Therefore $a^2 : a^2 - b^2 = \frac{4}{3} \pi b^3 : \frac{2}{3} \pi b^3 \frac{a^2 - b^2}{a^2}$, which is the quantity of protuberant matter. We may, without sensible error, suppose $\frac{a^2 - b^2}{a^2} = 2d$.

Precession. $= 2d$; then the protuberant matter will be $\frac{4}{5}\pi b^2 d$. If all this were placed at O, the momentum would be $\frac{4}{5}\pi db^2 f \cdot OH \cdot HC$, $= \frac{4}{5}\pi m n f d b^4$, because $OH \cdot HC = m n b^2$; now $\frac{4}{5}$ is 5 times $\frac{1}{5}$.

Also, because the sum of all the rectangles $OH \cdot HC$ round the equator is half of as many squares of OC , it follows that the momentum of the protuberant matter placed in a ring round the equator of the sphere or spheroid is one half of what it would be if collected in the point O or E; whence it follows that the momentum of the protuberant matter in its natural place is two-fifths of what it would be if it were disposed in an equatorial ring. It was in this manner that Sir Isaac Newton was enabled to compare the effect of the sun's action on the protuberant matter of the earth, with his effect on a rigid ring of moons. The preceding investigation of the momentum is nearly the same with his, and appears to us greatly preferable in point of perspicuity to the fluxionary solutions given by later authors. These indeed have the appearance of greater accuracy, because they do not suppose all the protuberant matter to be condensed on the surface of the inscribed sphere: nor were we under the necessity of doing this, only it would have led to very complicated expressions had we supposed the matter in each line AQ collected in its centre of oscillation or gyration. We made a compensation for the error introduced by this, which may amount to $\frac{1}{15}$ of the whole, and should not be neglected, by taking d as equal to $\frac{a^2 - b^2}{2a}$ instead of $\frac{a^2 - b^2}{a + b}$.

The consequence is, that our formula is the same with that of the later authors.

Thus far Sir Isaac Newton proceeded with mathematical rigour; but in the application he made two assumptions, or, as he calls them, hypotheses, which have been found to be unwarranted. The first was, that when the ring of protuberant matter is connected with the inscribed sphere, and subjected to the action of the disturbing force, the same quantity of motion is produced in the whole mass as in the ring alone. The second was, that the motion of the nodes of a rigid ring of moons is the same with the mean motion of the nodes of a solitary moon. But we are now able to demonstrate, that it is not the quantity of motion, but of momentum, which remains the same, and that the nodes of a rigid ring move twice as fast as those of a single particle. We proceed therefore to

Prob. 2. To determine the deviation of the axis, and the retrograde motion of the nodes which result from this libratory momentum of the earth's protuberant matter.

But here we must refer our readers to some fundamental propositions of rotatory motions which are demonstrated in the article *ROTATION*.

If a rigid body is turning round an axis A , passing through its centre of gravity with the angular velocity a , and receives an impulse which alone would cause it to turn round an axis B , also passing through its centre of gravity, with the angular velocity b , the body will now turn round a third axis C , passing through its centre of gravity, and lying in the plane of the axes A and B , and the sine of the inclination of this third axis to the axis A will be to the sine of inclination to the axis B as the velocity b to the velocity a .

When a rigid body is made to turn round any axis by the action of an external force, the quantity of

momentum produced (that is, the sum of the products of every particle by its velocity and by its distance from the axis) is equal to the momentum or similar product of the moving force or forces.

If an oblate spheroid, whose equatorial diameter is a and polar diameter b , be made to librate round an equatorial diameter, and the velocity of that point of the equator which is farthest from the axis of libration be v , the momentum of the spheroid is $\frac{4}{15}\pi a^2 b^2 v$.

The two last are to be found in every elementary book of mechanics.

Let AN (fig. 4.) be the plane of the earth's equator, cutting the ecliptic CNK in the line of the nodes or equinoctial points Nn . Let OAS be the section of the earth by a meridian passing through the sun, so that the line OCS is in the ecliptic, and CA is an arch of an hour-circle or meridian, measuring the sun's declination. The sun not being in the plane of the equator, there is, by prop. 1. a force tending to produce a libration round an axis ZOz at right angles to the diameter Aa of that meridian in which the sun is situated, and the momentum of all the disturbing forces is $\frac{4}{15}\pi m n f d \pi b^4$. The product of any force by the moment i of its action expresses the momentary increment of velocity; therefore the momentary velocity, or the velocity of libration generated in the time i is $\frac{4}{15}\pi m n f d \pi b^4 i$. This is the absolute velocity of a point at the distance 1 from the axis, or it is the space which would be uniformly described in the moment i , with the velocity which the point has acquired at the end of that moment. It is double the space actually described by the libration during that moment; because this has been an uniformly accelerated motion, in consequence of the continued and uniform action of the momentum during this time. This must be carefully attended to, and the neglect of it has occasioned very faulty solutions of this problem.

Let v be the velocity produced in the point A , the most remote from the axis of libration. The momentum excited or produced in the spheroid is $\frac{4}{15}\pi a^2 b^2 v$ (as above), and this must be equal to the momentum of the moving force, or to $\frac{4}{15}\pi m n f d \pi b^4 i$; therefore we obtain $v = \frac{\frac{4}{15}\pi m n f d \pi b^4 i}{\frac{4}{15}\pi a^2 b^2}$, that is, $v = m n f d i \frac{b^2}{a^2}$ or ve-

ry nearly $m n f d i$, because $\frac{b^2}{a^2} = 1$ very nearly. Also, because the product of the velocity and time gives the space uniformly described in that time, the space described by A in its libration round Zz is $m n f d i^2$, and the angular velocity is $\frac{m n f d i}{a}$.

Let \dot{r} be the momentary angle of diurnal rotation. The arch Ar , described by the point A of the equator in this moment i will therefore be $a \dot{r} i$, that is, $a \times r$, and the velocity of the point A is $\frac{a \dot{r}}{i}$, and the angular velocity of rotation is $\frac{\dot{r}}{i}$.

Here then is a body (fig. 5.) turning round an axis OP , perpendicular to the plane of the equator zoz , and therefore situated in the plane ZPz ; and it turns round this

31
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Precession.

this axis with the angular velocity $\frac{r}{t}$. It has received an impulse, by which alone it would librate round the axis Zz , with the angular velocity $\frac{mnfdt}{a}$. It will therefore turn round neither axis ($n^{\circ} 31.$), but round a third axis OP' , passing through O , and lying in the plane ZPz , in which the other two are situated, and the sine $P'P$ of its inclination to the axis of libration Zz will be to the sine Pp of its inclination to the axis OP of rotation as $\frac{r}{t}$ to $\frac{mnfdt}{a}$.

Now A , in fig. 4. is the summit of the equator both of libration and rotation; $mnfdt^2$ is the space described by its libration in the time t ; and ar is the space or arch Ar (fig. 4.) described in the same time by its rotation: therefore, taking Ar to Ac (perpendicular to the plane of the equator of rotation, and lying in the equator of libration), as ar to $mnfdt^2$, and completing the parallelogram $Armc$, Am will be the compound motion of A ($n^{\circ} 31.$), and $ar : mnfdt^2 = 1 : \frac{mnfdt^2}{ar}$, which will be the tangent of the angle mar , or of the change of position of the equator. But the axes of rotation are perpendicular to their equator; and therefore the angle of deviation ω is equal to this angle mar . This appears from fig. 5.; for $\angle P : Pp = Op : P'p = Op : \tan. POP$; and it is evident that $ar : mnfdt^2 = \frac{r}{t} : mnfd\frac{t}{a}$, as is required by the composition of rotations.

In consequence of this change of position, the plane of the equator no longer cuts the plane of the ecliptic in the line Nn . The plane of the new equator cuts the former equator in the line AO , and the part AN of the former equator lies between the ecliptic and the new equator AN , while the part An of the former equator is above the new one An ; therefore the new node N' , from which the point A was moving, is removed to the westward, or farther from A ; and the new node n' , to which A is approaching, is also moved westward, or nearer to A ; and this happens in every position of A . The nodes, therefore, or equinoctial points, continually shift to the westward, or in a contrary direction to the rotation of the earth; and the axis of rotation always deviates to the east side of the meridian which passes through the sun.

This account of the motions is extremely different from what a person should naturally expect. If the earth were placed in the summer solstice, with respect to us who inhabit its northern hemisphere, and had no rotation round its axis, the equator would begin to approach the ecliptic, and the axis would become more upright; and this would go on with a motion continually accelerating, till the equator coincided with the ecliptic. It would not stop here, but go as far on the other side, till its motion were extinguished by the opposing forces; and it would return to its former position, and again begin to approach the ecliptic, playing up and down like the arm of a balance. On this account this motion is very properly termed *libration*; but this very slow libration, compounded with the incomparably swifter motion of diurnal rotation, produces a third mo-

tion extremely different from both. At first the north pole of the earth inclines forward toward the sun; after a long course of years it will incline to the left hand, as viewed from the sun, and be much more inclined to the ecliptic, and the plane of the equator will pass through the sun. Then the south pole will come into view, and the north pole will begin to decline from the sun; and this will go on (the inclination of the equator diminishing all the while) till, after a course of years, the north pole will be turned quite away from the sun, and the inclination of the equator will be restored to its original quantity. After this the phenomena will have another period similar to the former, but the axis will now deviate to the right hand. And thus, although both the earth and sun should not move from their places, the inhabitants of the earth would have a complete succession of the seasons accomplished in a period of many centuries. This would be prettily illustrated by an iron ring poised very nicely on a cap like the card of a mariner's compass, having its centre of gravity coinciding with the point of the cap, so that it may whirl round in any position. As this is extremely difficult to execute, the cap may be pierced a little deeper, which will cause the ring to maintain a horizontal position with a very small force. When the ring is whirling very steadily, and pretty briskly, in the direction of the hours of a watch-dial, hold a strong magnet above the middle of the nearer semicircle (above the 6 hour point) at the distance of three or four inches. We shall immediately observe the ring rise from the 9 hour point, and sink at the 3 hour point, and gradually acquire a motion of precession and nutation, such as has been described.

If the earth be now put in motion round the sun, or the sun round the earth, motions of libration and deviation will still obtain, and the succession of their different phases, if we may so call them, will be perfectly analogous to the above statement. But the quantity of deviation, and change of inclination, will now be prodigiously diminished, because the rapid change of the sun's position quickly diminishes the disturbing forces, annihilates them by bringing the sun into the plane of the equator, and brings opposite forces into action.

We see in general that the deviation of the axis is always at right angles to the plane passing through the sun, and that the axis, instead of being raised from the ecliptic, or brought nearer to it, as the libration would occasion, deviates sidewise; and the equator, instead of being raised or depressed round its east and west points, is twisted sidewise round the north and south points; or at least things have this appearance: but we must now attend to this circumstance more minutely.

The composition of rotation shows us that this change of the axis of diurnal rotation is by no means a translation of the former axis (which we may suppose to be the axis of figure) into a new position, in which it again becomes the axis of diurnal motion; nor does the equator of figure, that is, the most prominent section of the terrestrial spheroid, change its position, and in this new position continue to be the equator of rotation. This was indeed supposed by Sir Isaac Newton; and this supposition naturally resulted from the train of reasoning which he adopted. It was strictly true of a single moon, or of the imaginary orbit attached to it; and therefore Newton supposed that the whole earth did in this manner deviate from its former position.

Precession.

Precession. tion, still, however, turning round its axis of figure. In this he has been followed by Walmesley, Simpson, and most of his commentators. D'Alembert was the first who entertained any suspicion that this might not be certain; and both he and Euler at last showed that the new axis of rotation was really a new line in the body of the earth, and that its axis and equator of figure did not remain the axis and equator of rotation. They ascertained the position of the real axis by means of a most intricate analysis, which obscured the connection of the different positions of the axis with each other, and gave us only a kind of momentary information. Father Frisius turned his thoughts to this problem, and fortunately discovered the composition of rotations as a general principle of mechanical philosophy. Few things of this kind have escaped the penetrating eye of Sir Isaac Newton. Even *this* principle had been glanced at by him. He affirms it in express terms with respect to a body that is perfectly spherical (cor. 22. prop. 66. B. I.) But it was reserved for Frisius to demonstrate it to be true of bodies of any figure, and thus to enrich mechanical science with a principle which gives simple and elegant solutions of the most difficult problems.

But here a very formidable objection naturally offers itself. If the axis of the diurnal motion of the heavens is not the axis of the earth's spheroidal figure, but an imaginary line in it, round which even the axis of figure must revolve; and if this axis of diurnal rotation has so greatly changed its position, that it now points at a star at least 12 degrees distant from the pole observed by Timochares, how comes it that the equator has the very same situation on the surface of the earth that it had in ancient times? No sensible change has been observed in the latitudes of places.

The answer is very simple and satisfactory: Suppose that in 12 hours the axis of rotation has changed from the position PR (fig. 6.) to pr , so that the north pole, instead of being at P, which we may suppose to be a particular mountain, is now at p . In this 12 hours the mountain P, by its rotation round pr , has acquired the position π . At the end of the next 12 hours, the axis of rotation has got the position πp , and the axis of figure has got the position pr , and the mountain P is now at p . Thus, on the noon of the following day, the axis of figure PR is in the situation which the real axis of rotation occupied at the intervening midnight. This goes on continually, and the axis of figure follows the position of the axis of rotation, and is never further removed from it than the deviation of 12 hours, which does not exceed $\frac{1}{706}$ th part of one second, a quantity altogether imperceptible. Therefore the axis of figure will always sensibly coincide with the axis of rotation, and no change can be produced in the latitudes of places on the surface of the earth.

Application of this reasoning to nutation and precession. We have hitherto considered this problem in the most general manner; let us now apply the knowledge we have gotten of the deviation of the axis or of the momentary action of the disturbing force to the explanation of the phenomena: that is, let us see what precession and what nutation will be accumulated after any given time of action.

For this purpose we must ascertain the precise deviation which the disturbing forces are competent to produce. This we can do by comparing the momentum of libration with the gravitation of the earth to the sun,

and this with the force which would retain a body on the equator while the earth turns round its axis.

The gravitation of the earth to the sun is in the proportion of the sun's quantity of matter M directly, and to the square of the distance A inversely, and may therefore

be expressed by the symbol $\frac{M}{A^2}$. The disturbing force at the distance r from the plane of illumination is to the gravitation of the earth's centre to the sun as 3 to A, (A being measured on the same scale which measures the distance from the plane of illumination). Therefore $\frac{3M}{A^3}$ will be the disturbing force f of our formula.

Let p be the centrifugal force of a particle at the distance r from the axis of rotation; and let t and T be the times of rotation and of annual revolution, viz.

sidereal day and year. Then $p = \frac{M}{A^2} = \frac{r}{t^2} : \frac{A}{T^2}$. Hence

we derive $\frac{3M}{A^3} = 3p \frac{t^2}{T^2}$. But since r was the angular velocity of rotation, and consequently $r \times r$ the space described, and $\frac{1 \times r}{t}$ the velocity; and since the

centrifugal force is as the square of the velocity divided by the radius, (this being the measure of the generated velocity, which is the proper measure of any accelerating force), we have $p = \frac{r \times r^2}{1 \times t^2} = \frac{r^3}{t^2}$, and $f = \frac{3r^3}{t^2}$.

$\times \frac{t^2}{T^2}$. Now the formula $f m n d \frac{t^2}{a}$ expressed the sine of the angle. This being extremely small, the sine may be considered as equal to the arc which measures the angle. Now, substitute for it the value now found, viz.

$\frac{3r^3}{t^2} \times \frac{t^2}{T^2}$, and we obtain the angle of deviation $\dot{\omega} = r \frac{3t^2}{T^2} m n \frac{d}{a}$, and this is the simplest form in which it can appear. But it is convenient, for other reasons, to express it a little differently: d is nearly equal to $\frac{a^2 - b^2}{2a^2}$,

therefore $\dot{\omega} = r \times \frac{3}{2} \frac{t^2}{T^2} m n \frac{a^2 - b^2}{a^2}$, and this is the form in which we shall now employ it.

The small angle $r \frac{3t^2}{2T^2} m n \frac{a^2 - b^2}{a^2}$ is the angle in which the new equator cuts the former one. It is different at different times, as appears from the variable part mn , the product of the sine and cosine of the sun's declination. It will be a maximum when the declination is in the solstice, for mn increases all the way to 45° , and the declination never exceeds $23\frac{1}{2}^\circ$. It increases, therefore, from the equinox to the solstice, and then diminishes.

Let ESL (fig. 7.) be the ecliptic, EAC the equator, BAD the new position which it acquires by the momentary action of the sun, cutting the former in the

angle BAE $= r \frac{3}{2} \frac{t^2}{T^2} m n \frac{a^2 - b^2}{a^2}$. Let S be the sun's place in the ecliptic, and AS the sun's declination, the meridian AS being perpendicular to the equator. Let $\frac{a^2 - b^2}{a^2}$ be k . The angle BAE is then $= r \frac{3t^2}{2T^2} kmn$. In

the

Precession. the spherical triangle BAE we have fin. B : fin. AE = fin. A : fin. BE, or = A : BE, because very small angles and arches are as their fines. Therefore BE, which is the momentary precession of the equinoctial point E, is equal to $A \frac{\text{fin. AE}}{\text{fin. B}} = r \times \frac{3t^2}{2T^2} k m n$, fin. R. ascenf. fin. obl. ecl.

35
Various
modes of
application.

The equator EAC, by taking the position BAD, recedes from the ecliptic in the colure of the solstices CL, and CD is the change of obliquity or the nutation. For let CL be the solstitial colure of BAD, and c / the solstitial colure of EAC. Then we have fin. B : fin. E = fin. LD : fin. lc ; and therefore the difference of the arches LD and lc will be the measure of the difference of the angles B and E. But when BE is indefinitely small, CD may be taken for the difference of LD and lc , they being ultimately in the ratio of equality. Therefore CD measures the change of the obliquity of the ecliptic, or the nutation of the axis with respect to the ecliptic.

The real deviation of the axis is the same with the change in the position of the equator, Pp being the measure of the angle EAB. But this not being always made in a plane perpendicular to the ecliptic, the change of obliquity generally differs from the change in the position of the axis. Thus when the sun is in the solstice, the momentary change of the position of the equator is the greatest possible; but being made at right angles to the plane in which the obliquity of the ecliptic is computed, it makes no change whatever in the obliquity, but the greatest possible change in the precession.

56

In order to find CD the change of obliquity, observe that in the triangle CAD, R : fin. AC, or R : cof. AE = fin. A : fin. CD, = A : CD (because A and CD are exceedingly small). Therefore the change of obliquity (which is the thing commonly meant by nutation) $CD = A \times \text{cof. AE} = r \frac{3t^2}{2T^2} k m n$, cof. AE' = $r \frac{3t^2}{2T^2} k \times \text{fin. declin.} \times \text{cof. declin.} \times \text{cof. R. ascenf.}$

37

But it is more convenient for the purposes of astronomical computation to make use of the sun's longitude SE. Therefore make

The sun's longitude ES	-	-	=	z
Sine of sun's long.	-	-	=	x
Cofine	-	$\sqrt{1-x^2}$	=	y
Sine obliq. eclipt.	-	-	$23\frac{1}{2}$	= p
Cofine obliq.	-	-	-	= q

38

In the spherical triangle EAS, right angled at A (because AS is the sun's declination perpendicular to the equator), we have R : fin. ES = fin. E : fin. AS, and fin. AS = $p \times x$. Also R : cof. AS = cof. AE : cof. ES, and cof. ES or $y = \text{cof. AS} \times \text{cof. AE}$. Therefore $p \times y = \text{fin. AS} \times \text{cof. AS} \times \text{cof. AE} = m n \times \text{cof. AE}$.

Therefore the momentary nutation $CD = r \times \frac{3t^2}{2T^2} k p x y$.

39

We must recollect that this angle is a certain fraction of the momentary diurnal rotation. It is more convenient to consider it as a fraction of the sun's annual motion, that so we may directly compare his motion on the ecliptic with the precession and nutation corresponding to his situation in the heavens. This change is easily made, by augmenting the fraction in the ratio of the sun's angular motion to the motion of

Vol. XV. Part II.

rotation, or multiplying the fraction by $\frac{T}{t}$; therefore **Precession.**

the momentary nutation will be $r \frac{3t}{2T} k p \times y$. In this value $\frac{3tkp}{2T}$ is a constant quantity, and the momentary nutation is proportional to $x y$, or to the product of the sine and cofine of the sun's longitude, or to the sine of twice the sun's longitude; for $x y$ is equal to half the sine of twice z .

If therefore we multiply this fraction by the sun's momentary angular motion, which we may suppose, with abundant accuracy, proportional to $\frac{z}{t}$, we obtain the fluxion of the nutation, the fluent of which will express the whole nutation while the sun describes the arch z of the ecliptic, beginning at the vernal equinox. Therefore, in place of y put $\sqrt{1-x^2}$, and in place

40

of z put $\frac{x}{\sqrt{1-x^2}}$, and we have the fluxion of the nutation for the moment when the sun's longitude is z , and the fluent will be the whole nutation. The fluxion resulting from this process is $\frac{3tkp}{2T} x$, of which the

fluent is $\frac{3tkp}{4T} x^2$. This is the whole change produced on the obliquity of the ecliptic while the sun moves along the arch z ecliptic, reckoned from the vernal equinox. When this arch is 90° , x^2 is 1, and therefore $\frac{3tkp}{4T}$ is the nutation produced while the sun moves from the equinox to the solstice.

The momentary change of the axis and plane of the equator (which is the measure of the changing force) is $\frac{3tk}{2T} m n$.

The momentary change of the obliquity of the ecliptic is $\frac{3tkp}{2T} x$. The whole change of obliquity is $\frac{3tkp}{4T} x^2$. Hence we see that the force and the real momentary change of position are greatest at the solstices, and diminish to nothing in the equinoxes. The momentary change of obliquity is greatest at the octants, being proportional to $x x$ or to $x y$. The whole accumulated change of obliquity is greatest at the solstices, the obliquity itself being then smallest. We must in like manner find the accumulated quantity of the precession after a given time, that is, the arch BE for a finite time.

41
The real
and mo-
mentary
changes
greatest at
the solstices
and at the
equinoxes,
nothing.

We have ER : CD = fin. EA : fin. CA (or cof. EA) = tan. EA : 1, and EB : ER = 1 : fin. B. Therefore EB : CD = tan. EA : fin. B. But tan. EA = cof. E \times tan. ES, = cof. E \times $\frac{\text{fin. long.}}{\text{cof. long.}} = \frac{q \times x}{\sqrt{1-x^2}}$.

42
Quantity
of preces-
sion in a
given
time.

Therefore EB : CD = $\frac{q \times x}{\sqrt{1-x^2}} p$, and CD = EB : $\frac{\text{fin. obliq. eclip.}}{\text{tan. long. } \odot}$. If we now substitute for CD its value found in n° 40. viz. $\frac{3tkp}{2T} x$, we obtain EB = $\frac{3t}{2T} \times \frac{k q x^2}{\sqrt{1-x^2}}$, the fluxion of the precession of the

Precession. equinoxes occasioned by the action of the sun. The fluent of the variable part $\frac{x^2 \dot{x}}{\sqrt{1-x^2}} = x \dot{y}$, of which the fluent is evidently a segment of a circle whose arch is z and sine x , that is, $= \frac{z - x\sqrt{1-x^2}}{2}$ and the whole precession, while the sun describes the arch z , is $\frac{3t}{2T} \times \frac{kq}{2} (2 - x\sqrt{1-x^2})$. This is the precession of the equinoxes while the sun moves from the vernal equinox along the arch z of the ecliptic.

In this expression, which consists of two parts, $\frac{3tkq}{4T}$ z , and $\frac{3tkq}{4T} (-x\sqrt{1-x^2})$, the first is incomparably greater than the second, which never exceeds 1'', and is always compensated in the succeeding quadrant. The precession occasioned by the sun will be $\frac{3tkq}{4T} z$, and from this expression we see that the precession increases uniformly, or at least increases at the same rate with the sun's longitude z , because the quantity $\frac{3tkq}{4T}$ is constant.

43
Mode of
using the
formulae.

In order to make use of these formulæ, which are now reduced to very great simplicity, it is necessary to determine the values of the two constant quantities $\frac{3tkp}{4T}$, $\frac{3tkq}{4T}$, which we shall call N and P , as factors of the nutation and precession. Now t is one sidereal day, and T is 366 $\frac{1}{2}$. k is $\frac{a^2 - b^2}{a^2}$, which according to Sir Isaac Newton is $\frac{231^2 - 230^2}{231^2} = \frac{1}{115}$; p and q are the sine and cosine of 23° 28', viz. 0,39822 and 0,91729.

These data give $N = \frac{1}{141030}$ and $P = \frac{1}{61224}$ of

which the logarithms are 4.85069 and 5.21308, viz. the arithmetical complements of 5.14931 and 4.78692.

44
Example of
the utility
of the in-
vestigation.

Let us, for an example of the use of this investigation, compute the precession of the equinoxes when the sun has moved from the vernal equinox to the summer solstice, so that z is 90°, or 324000'.

Log 324000" = z - - - 5.51055

Log P - - - 5.21308

Log 5",292 - - - 0.72363

The precession therefore in a quarter of a year is 5,292 seconds; and, since it increases uniformly, it is 21",168 annually.

45
Assump-
tions on
which the
computa-
tion pro-
ceeds.

We must now recollect the assumptions on which this computation proceeds. The earth is supposed to be homogeneous, and the ratio of its equatorial diameter to its polar axis is supposed to be that of 231 to 230. If the earth be more or less protuberant at the equator, the precession will be greater or less in the ratio of this protuberance. The measures which have been taken of the degrees of the meridian are very inconsistent among themselves; and although a comparison of them all indicates a smaller protuberancy, nearly $\frac{1}{117}$ instead of $\frac{1}{115}$, their differences are too great to leave much confidence in this method. But if this

figure be thought more probable, the precession will be reduced to about 17" annually. But even though the figure of the earth were accurately determined, we have no authority to say that it is homogeneous. If it be denser towards the centre, the momentum of the protuberant matter will not be so great as if it were equally dense with the inferior parts, and the precession will be diminished on this account. Did we know the proportion of the matter in the moon to that in the sun, we could easily determine the proportion of the whole observed annual precession of 50 $\frac{1}{2}$ " which is produced by the sun's action. But we have no unexceptionable data for determining this; and we are rather obliged to infer it from the effect which she produces in disturbing the regularity of the precession, as will be considered immediately. So far, therefore, as we have yet proceeded in this investigation, the result is very uncertain. We have only ascertained unquestionably the law which is observed in the solar precession. It is probable, however, that this precession is not very different from 20" annually; for the phenomena of the tides show the disturbing force of the sun to be very nearly $\frac{2}{7}$ of the disturbing force of the moon. Now 20" is $\frac{2}{7}$ of 50'.

But let us now proceed to consider the effect of the moon's action on the protuberant matter of the earth; and as we are ignorant of her quantity of matter, and consequently of her influence in similar circumstances with the sun, we shall suppose that the disturbing force of the moon is to that of the sun as m to 1. Then

(*ceteris paribus*) the precession will be to the solar precession π in the ratio of the force and of the time of its action jointly. Let t and T therefore represent a periodical month and year, and the lunar precession will be $= \frac{m \pi t}{T}$. This precession must be reckoned on the

plane of the lunar orbit, in the same manner as the solar precession is reckoned on the ecliptic. We must

also observe, that $\frac{m \pi t}{T}$ represents the lunar precession

only on the supposition that the earth's equator is inclined to the lunar orbit in an angle of 23 $\frac{1}{2}$ degrees. This is indeed the mean inclination; but it is sometimes increased to above 28°, and sometimes reduced to 18°. Now in the value of the solar precession the cosine of the obliquity was employed. Therefore whatever is the angle E contained between the equator and the lunar orbit, the precession will be $= \frac{m \pi t}{T} \cdot \frac{\text{Cof. } E}{\text{Cof. } 23\frac{1}{2}^\circ}$,

and it must be reckoned on the lunar orbit.

Now let VB (fig. 8.) be the immoveable plane of the ecliptic, $VED \perp F$ the equator in its first situation, before it has been deranged by the action of the moon, $AGRDBH$ the equator in its new position, after the momentary action of the moon. Let $EGNFH$ be the moon's orbit, of which N is the ascending node, and the angle $N = 5^\circ 8' 46'$.

Let NV the long. of the node be - - - z
Sine NV - - - - - x
Cosine NV - - - - - y
Sine $V = 23\frac{1}{2}$ - - - - - a
Cosine V - - - - - b
Sine $N = 5.8.46$ - - - - - c
Cosine N - - - - - d
Circumference to radius 1, = 6,28 - - - e

Force

Precession.

46

47

Precession.

Force of the moon
Solar precession (supposed $= 14\frac{1}{2}''$ by obser-
vation)
Revolution of $\odot = 27^d \frac{1}{4}$
Revolution of $\ominus = 366\frac{1}{4}$
Revolution of $\text{N} = 18$ years 7 months

m

 π

t

T

n

while the node continually changes its place, and in the space of 18 years makes a complete tour of the heavens.

We must, therefore, take the motion of the node as the fluent of comparison, or we must compare the fluxions of the node's motion with the fluxions of the precession and nutation; therefore, let the longitude of the node be z , and its monthly change $= \dot{z}$; we shall then have

$$t : n :: z : e, \text{ and } t = \frac{n z}{e}, = \frac{n x}{e \sqrt{1-x^2}}. \text{ Let } T \text{ be } = 1,$$

in order that n may be 18,6, and substitute for t its value in the fluxion of the nutation, by putting $\sqrt{1-x^2}$

in place of y . By this substitution we obtain $m \pi n \frac{e}{e b}$

$$\left(\frac{d b x \dot{x}}{\sqrt{1-x^2}} - a c x \dot{x} \right). \text{ The fluent of this is } m \pi n \frac{e}{e b}$$

$$\left(-d b \sqrt{1-x^2} - \frac{a c x^2}{2} \right). \text{ (Vide Simpson's Fluxions, § 77).}$$

But when x is $= 0$, the nutation must be $= 0$, because it is from the position in the equinoctial points that all our deviations are reckoned, and it is from this point that the periods of the lunar action recommences. But if we make $x = 0$ in this expression, the term

$$-\frac{a c x^2}{2} \text{ vanishes, and the term } -d b \sqrt{1-x^2} \text{ becomes } = -d b;$$

therefore our fluent has a constant part $+d b$; and the complete fluent is $m \pi n \frac{e}{e b} (d b - d b \sqrt{1-x^2} -$

$$\frac{a c x^2}{2}). \text{ Now this is equal to } m \pi n \frac{e}{e b} (d b \times \text{versed}$$

sine, $z - \frac{1}{2} a c \times \text{versed sine } z z)$: For the versed sine of z is equal to $(1 - \cos. z)$; and the square of the sine of an arch is $\frac{1}{2}$ the versed sine of twice that arch.

This, then, is the whole nutation while the moon's ascending node moves from the vernal equinox to the longitude $\varphi \text{N} = z$. It is the expression of a certain number of seconds, because π , one of its factors, is the solar precession in seconds; and all the other factors are numbers, or fractions of the radius 1; even e is expressed in terms of the radius 1.

The fluxion of the precession, or the monthly precession, is to that of the nutation as the cotangent of φE is to the sine of φ . This also appears by considering figure 7. Pp measures the angle A , or change of position of the equator; but the precession itself, reckoned on the ecliptic, is measured by Po , and the nutation by po ; and the fluxion of the precession is equal to the fluxion of

$$\text{nutation} \times \frac{\cot. \varphi \text{E}}{\text{sine } \varphi}, \text{ but } \cot. \varphi \text{E} = \frac{a d + b c y}{a x}; \text{ there-}$$

$$\text{fore } \frac{\cot. \varphi \text{E}}{\text{sine } \varphi} = \frac{a d + b c \sqrt{1-x^2}}{c x} : \text{ This, multiplied into}$$

$$\text{the fluxion of the nutation, gives } \frac{m \pi n}{a b e} \left(\frac{a b d^2}{\sqrt{1-x^2}} + \right.$$

$$\left. (b^2 - a^2) d c - a b c^2 \sqrt{1-x^2} \right) \dot{x} \text{ for the monthly pre-}$$

$$\text{cession. The fluent of this } \frac{m \pi n}{a b e} (a d^2 b z + (b^2 - a^2)$$

$$d c x - \frac{1}{2} a b c^2 z - \frac{1}{2} a b c^2 x \sqrt{1-x^2}), \text{ or it is equal}$$

$$\text{to } \frac{m \pi n}{a b e} \left((d^2 - \frac{1}{2} c^2) a b z + (b^2 - a^2) d c z - \frac{1}{4} a b c^2 \right.$$

$$\left. \text{sine } 2z \right).$$

48

Lunar precession in a month reduced to the ecliptic.

In order to reduce the lunar precession to the ecliptic, we must recollect that the equator will have the same inclination at the end of every half revolution of the sun or of the moon, that is, when they pass through the equator, because the sum of all the momentary changes of its position begins again each revolution. Therefore if we neglect the motion of the node during one month, which is only $1\frac{1}{2}$ degrees, and can produce but an insensible change, it is plain that the moon produces, in one half revolution, that is, while she moves from H to G, the greatest difference that she can in the position of the equator. The point D, therefore, half-way from G to H, is that in which the moveable equator cuts the primitive equator, and DE and DF are each 90° . But S being the solstitial point, φS is also 90° . Therefore $\text{DS} = \varphi \text{E}$. Therefore, in the triangle DGE, we have $\sin. \text{ED} : \sin. \text{G} = \sin. \text{EG} : \sin. \text{D}$, $= \text{EG} : \text{D}$. Therefore $\text{D} = \text{EG} \times \sin. \text{G}$, $= \text{EG} \times \sin. \text{E}$ nearly. Again, in the triangle φDA we have $\sin. \text{A} : \sin. \varphi \text{D}$ (or $\cos. \varphi \text{E}$) $= \sin. \text{D} : \sin. \varphi \text{A}$, $= \text{D} : \varphi \text{A}$. Therefore $\varphi \text{A} = \frac{\text{D} \cdot \cos. \varphi \text{E}}{\sin. \text{A}}$, $= \frac{\text{EG} \cdot \sin. \text{E} \cdot \cos. \varphi \text{E}}{\sin. 23\frac{1}{2}}$, $= \frac{m \pi t}{T} \frac{\sin. \text{E} \cdot \cos. \text{E} \cdot \cos. \varphi \text{E}}{\sin. \varphi \cdot \cos. \varphi}$.

49

This is the lunar precession produced in the course of one month, estimated on the ecliptic, not constant like the solar precession, but varying with the inclination or the angle E or F, which varies both by a change in the angle N, and also by a change in the position of N on the ecliptic.

50
Nutation in the same time,

We must find in like manner the nutation SR produced in the same time, reckoned on the colure of the solstices RL. We have $\text{R} : \sin. \text{DS} = \text{D} : \text{RS}$, and $\text{RS} = \text{D} \cdot \sin. \text{DS}$, $= \text{D} \cdot \sin. \varphi \text{E}$. But $\text{D} = \text{EG} \cdot \sin. \text{E}$.

$$\text{Therefore } \text{RS} = \text{EG} \cdot \sin. \text{E} \cdot \sin. \varphi \text{E}, = \frac{m \pi t \cos. \text{E}}{T \cdot \cos. \varphi}$$

$\times \sin. \text{E} \times \sin. \varphi \text{E}$. In this expression we must substitute the angle N, which may be considered as constant during the month, and the longitude φN , which is also nearly constant, by observing that $\sin. \text{E} : \sin. \varphi \text{N} = \sin. \text{N} : \sin. \varphi \text{E}$. Therefore $\text{RS} = \frac{m \pi t}{T} \times \frac{\sin. \text{N} \cdot \sin. \varphi \text{N} \cdot \cos. \text{E}}{\cos. \varphi}$.

But we must exterminate the angle E, because it changes by the change of the position of N. Now, in the triangle φEN we have $\cos. \text{E} = \cos. \varphi \text{N} \cdot \sin. \text{N} : \sin. \varphi - \cos. \text{N} \cdot \cos. \varphi$, $= y c a - d b$. And because the angle E is necessarily obtuse, the perpendicular will fall without the triangle, the cosine of E will be negative, and we shall have $\cos. \text{E} = b d - a c y$. Therefore the nutation

$$\text{for one month will be } = \frac{m \pi t}{T} \times \frac{c x (b d - a c y)}{b}, \text{ the node}$$

being supposed all the while in N.

51
May be considered as momentary parts of the moon's action.

These two expressions of the monthly precession and nutation may be considered as momentary parts of the moon's action, corresponding to a certain position of the node and inclination of the equator, or as the fluxions of the whole variable precession and nutation,

Precession.

55

Let us now express this in numbers: When the node has made a half revolution, we have $z = 180^\circ$, whose versed sine is 2, and the versed sine of $2z$, or 360° , is $= 0$; therefore, after half a revolution of the node, the nutation ($n^\circ 52.$) becomes $\frac{m \pi n c}{e b} 2 b d$. If, in this expression, we suppose $m = 2\frac{1}{2}$, and $\pi = 14\frac{1}{2}''$, we shall find the nutation to be $19\frac{1}{2}''$.

56

Now the observed nutation is about $18''$. This requires m to be $2\frac{1}{6}$, and $\pi = 16\frac{1}{4}''$. But it is evident, that no astronomer can pretend to warrant the accuracy of his observations of the nutation within $1''$.

To find the lunar precession during half a revolution of the node, observe, that then z becomes $= \frac{e}{2}$, and the sine of z and of $2z$ vanish, d^2 becomes $1 - c^2$, and the precession becomes $\frac{m \pi n}{2} (d^2 - \frac{1}{2} c^2)$, $= \frac{m \pi n}{2} (1 - \frac{1}{2} c^2)$, and the precession in 18 years is $m \pi n \frac{1 - \frac{1}{2} c^2}{2}$.

57

We see, by comparing the nutation and precession for nine years, that they are as $\frac{4 c d}{e}$ to $1 - \frac{1}{2} c^2$ nearly as 1 to $17\frac{1}{2}$. This gives $313''$ of precession, corresponding to $18''$, the observed nutation, which is about $35'$ of precession annually produced by the moon.

58
Gives the
disturbing
force and
matte. of
the moon.

And thus we see, that the inequality produced by the moon in the precession of the equinoxes, and, more particularly, the nutation occasioned by the variable obliquity of her orbit, enables us to judge of her share in the whole phenomenon; and therefore informs us of her disturbing force, and therefore of her quantity of matter. This phenomenon, and those of the tides, are the only facts which enable us to judge of this matter: and this is one of the circumstances which has caused this problem to occupy so much attention. Dr Bradley, by a nice comparison of his observations with the mathematical theory, as it is called, furnished him by Mr Machin, found that the equation of precession computed by that theory was too great, and that the theory would agree better with the observations, if an ellipse were substituted for Mr Machin's little circle. He thought that the shorter axis of this ellipse, lying in the colure of the solstices, should not exceed $16''$. Nothing can more clearly show the astonishing accuracy of Bradley's observations than this remark: for it results from the theory, that the pole must really describe an ellipse, having its shorter axis in the solstitial colure, and the ratio of the axes must be that of 18 to 16,8; for the mean precession during a half revolution of the node is $\frac{m \pi n}{2} (d^2 - \frac{c^2}{2})$; and therefore, for the longi-

tude z , it will be $\frac{z m \pi n}{e} (d^2 - \frac{c^2}{2})$; when this is taken from the true precession for that longitude ($n^\circ 54.$), it leaves the equation of precession: $\frac{m \pi n}{a b e} ((b^2 - a^2) d c \text{ fine } z - \frac{1}{2} a b c \text{ fine } 2z)$; therefore, when the node is in the solstice, and the equation greatest, we have it $= \frac{m \pi n c d}{a b e} (b^2 - a^2)$. We here neglect the second term as insignificant.

59
Greatest
equation of
precession,

This greatest equation of precession is to $\frac{z m \pi n c d}{e}$,

the nutation of $18''$, as $b^2 - a^2$ to $2 a b$; that is, as radius to the tangent of twice the obliquity of the ecliptic. This gives the greatest equation of precession $16''$, 8, not differing half a second from Bradley's observations.

Precession
||
Predestina-
tion.

Thus have we attempted to give some account of this curious and important phenomenon. It is curious, because it affects the whole celestial motions in a very intricate manner, and received no explanation from the more obvious application of mechanical principles, which so happily accounted for all the other appearances. It is one of the most illustrious proofs of Sir Isaac Newton's sagacity and penetration, which caught at a very remote analogy between this phenomenon and the libration of the moon's orbit. It is highly important to the progress of practical and useful astronomy, because it has enabled us to compute tables of such accuracy, that they can be used with confidence for determining the longitude of a ship at sea. This alone fixes its importance: but it is still more important to the philosopher, affording the most incontestable proof of the universal and mutual gravitation of all matter to all matter. It left nothing in the solar system unexplained from the theory of gravity but the acceleration of the moon's mean motion; and this has at last been added to the list of our acquisitions by Mr de la Place.

Quæ toties animos veterum torfere Sophorum,
Quæque scholas frustra raucò certamine vexant,
Obvia conspicimus, nubè pellente Mathesi,
Jam dubios nulla caligine prægravat error
Queis superùm penetrare domos, atque ardua cœli
Scandere sublimis genii concessit acumen.
Nec fas est propius mortali attingere divos.

Halley.

PRECIE, (*precus*, "early,") the name of the 21st order in Linnæus's fragments of a natural method; consisting of primrose, an early flowering plant, and a few genera which agree with it in habit and structure, though not always in the character or circumstance expressed in the title. See BOTANY, p. 461. col. 2.

PRECIPITANT, in chemistry, is applied to any liquor, which, when poured on a solution, separates what is dissolved, and makes it precipitate, or fall to the bottom of the vessel.

PRECIPITATE, in chemistry, a substance which, having been dissolved in a proper menstruum, is again separated from its solvent, and thrown down to the bottom of the vessel, by pouring some other liquor upon it.

PRECIPITATION. See CHEMISTRY-Index.

PRECOGNITION, in Scots law. See LAW, Part III. n. CLXXXVI. 43.

PRECORDIA, in anatomy, a general name for the parts situated about the heart, in the forepart of the thorax: as the diaphragm, pericardium, and even the heart itself, with the spleen, lungs, &c.

PREDECESSOR, properly signifies a person who has preceded or gone before another in the same office or employment; in which sense it is distinguished from ancestor.

PREDESTINATION, the decree of God, where-
by he hath from all eternity unchangeably appointed
whatsoever comes to pass; and hath more especially
fore-ordained certain individuals of the human race to
everlasting

Fig. 1.

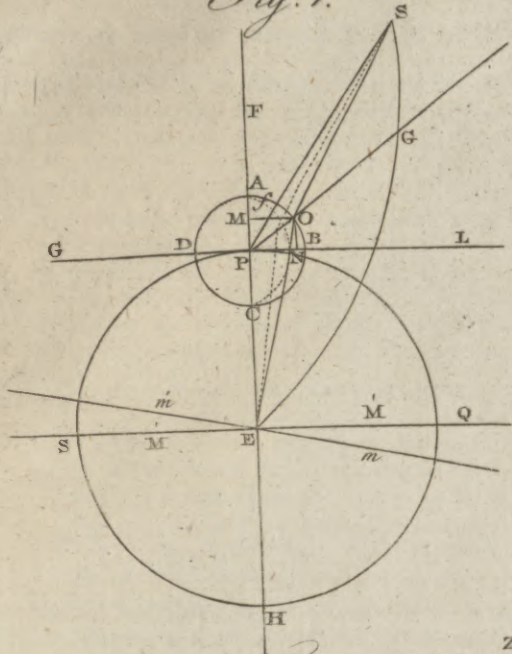


Fig. 3.

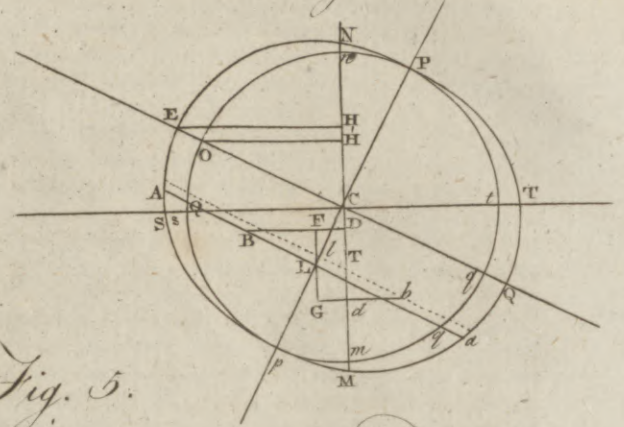


Fig. 5.

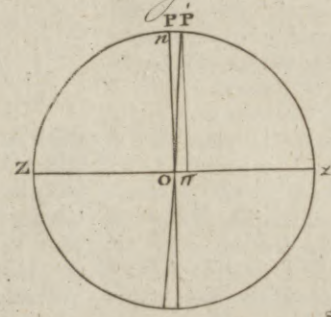


Fig. 4.

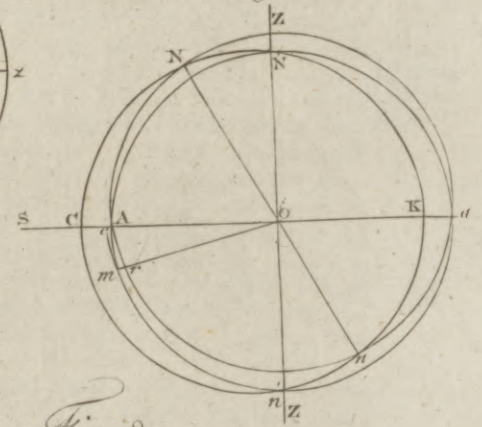


Fig. 7.

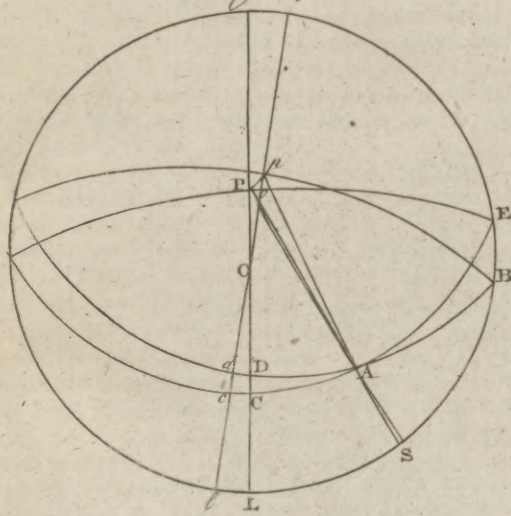


Fig. 8.

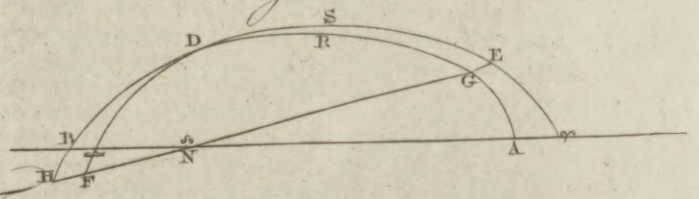


Fig. 2.

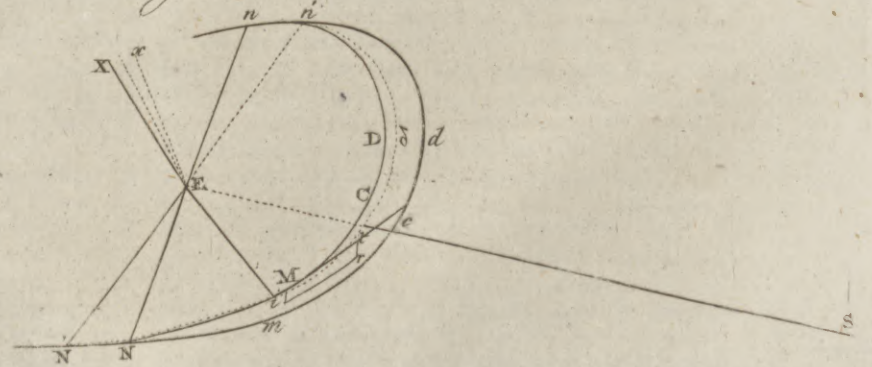
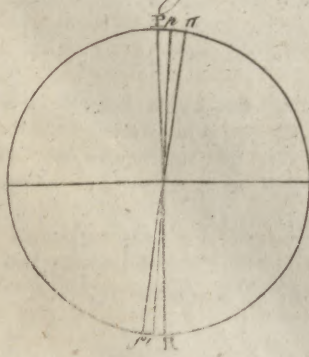


Fig. 6.



**Predestina-
tion** — everlasting happiness, and hath passed by the rest, and fore-ordained them to everlasting misery. The former of these are called the *elect*, and the latter are called the *reprobate*.

² Not pecu-
liar to
Christiani-
ty. This doctrine is the subject of one of the most perplexing controversies that has occurred among mankind. But it is not altogether peculiar to the Christian faith. The opinion, that whatever occurs in the world at large, or in the lot of private individuals, is the result of a previous and unalterable arrangement by that Supreme Power which presides over nature, has always been a favourite opinion among the vulgar, and has been believed by many speculative men. Thus, in that beautiful scene in the sixth book of the Iliad, Hector, taking leave of his wife and his child, speaks thus :

Andromache ! my soul's far better part,
Why with untimely sorrows leaves thy heart ?
No hostile hand can antedate my doom,
Till fate condemns me to the silent tomb.
Fix'd is the term to all the race of earth,
And such the hard condition of our birth.
No force can then resist, no flight can save,
All sink alike, the fearful and the brave. l. 624.

The ancient Stoics, Zeno and Chrysippus, whom the Jewish Essenes seem to have followed, asserted the existence of a Deity that, acting wisely, but necessarily, contrived the general system of the world ; from which, by a series of causes, whatever is now done in it unavoidably results. This series, or concatenation of causes, they held to be necessary in every part ; and that God himself is so much the servant of necessity, and of his own decrees, that he could not have made the smallest object in the world otherwise than it now is, much less is he able to alter any thing.

According to the words of Seneca, *Eodem necessitas et Deus a'ligat. Irrevocabilis divina pariter atque humana cursus vehit. Ille ipse omnium conditor ac rector scripsit quidem fata sed sequitur. Semper paret, semel justit.* "The same chain of necessity constrains both gods and men. Its unalterable course regulates divine as well as human things. Even he who wrote the Fates, the Maker and Governor of all things, submits to them. He did but once command, but he always obeys." The stoical fate differs, however, from the Christian predestination in several points. They regarded the divine nature and will as a necessary part of a necessary chain of causes ; whereas the Christians consider the Deity as the Lord and Ruler of the Universe, omnipotent and free, appointing all things according to his pleasure. Being doubtful of the immortality of the soul, the Stoics could have no idea of the doctrine of election and reprobation ; nor did they ever doubt their own freedom of will, or power of doing good as well as evil, as we shall presently see the Christian predestinarians have done.

Mahomet introduced into his Koran the doctrine of an absolute predestination of the course of human affairs. He represented life and death, prosperity and adversity, and every event that befalls a man in this world, as the result of a previous determination of the one God who rules over all ; and he found this opinion the best engine for inspiring his followers with that contempt of danger which, united to their zeal, has extend-

ed the empire of their faith over the fairest portion of Predestina-
the habitable globe. tion.

The controversy concerning predestination first made its appearance in the Christian church about the begin-³ When first
ning of the fifth century †. Pelagius a British, and Cœ- agitated in
lestius an Irish, monk, both lived at Rome during that the church.
period, and possessed great celebrity on account of their † *Mosheim.*
piety and learning. They taught that the opinion is *Insit. Hist.*
false, which asserts, that human nature is necessarily *Eccles.*
corrupted by a depravity derived from our first parents. — They contended, that men are born at present in a state as pure as that in which Adam was originally created ; and that they are not less qualified than he was for fulfilling all righteousness, and for reaching the most sublime eminence of piety and virtue : that the external grace of God, which is given unto all, and attends the preaching of the gospel, is necessary to call forth the attention and exertions of men ; but that we do not want the assistance of any internal grace to purify the heart, and to give it the first impulse towards what is good. Having fled into Africa on account of the Goths, who at that time invaded Italy, A. D. 410, Cœlestius remained at Carthage as a Presbyter ; but Pelagius went into the East, where he settled, and prospered under the patronage of John bishop of Jerusalem, to whom his sentiments were agreeable. On the contrary, the celebrated Augustine, bishop of Hippo, strenuously asserted the depravity of human nature since the fall of the first man, the necessity of a special interposition of divine grace to enable us to do any one good action ; and consequently, that none could obtain salvation excepting those whom God has thought fit to elect, and upon whom he bestows this grace. The dispute was carried on with great zeal. Zozimus bishop of Rome decided at first in favour of Pelagius and Cœlestius, whose followers were called *Pelagians* ; but he afterwards altered his opinion : and by the activity of Augustine, the council of Ephesus was called, at which the opinion of his antagonists was formally condemned.

⁴ Augustine =
a predesti-
narian. In the course of the same century, these opinions assumed a variety of forms and modifications. One party, called *Predestinarians*, carried Augustine's doctrine fully farther than he himself had ventured to do in express words ; and asserted, that God had not only predestinated the wicked to *punishment*, but also that he had decreed that they should commit those very *sins* on account of which they are hereafter to be punished. — Another party moderated the doctrine of Pelagius, and were called *Semipelagians*. Their peculiar opinion is expressed in a different manner by different writers ; but all the accounts sufficiently agree. Thus, some represent them as maintaining that inward grace is not necessary to the first beginning of repentance, but only to our progress in virtue. Others say, that they acknowledged the power of grace, but said that faith depends upon ourselves, and good works upon God ; and it is agreed upon all hands, that these Semipelagians held that predestination is made upon the foresight of good works. The assistance of Augustine, though then far advanced in life, was called in to combat these tenets, and he wrote several treatises upon the subject. In all these he strenuously maintained, that the predestination of the elect was independent of any foresight of

Predestina-
tion.

of their good works, but was according to the good pleasure of God only; and that perseverance comes from God, and not from man. Thereafter the doctrine of Augustine, or St Austin as he is often called, became general. He was the oracle of the schoolmen. They never ventured to differ from him in sentiment; they only pretended to dispute about the true sense of his writings.

5
And all the
earliest re-
formers,
but more
especially
Calvin.

The whole of the earliest reformers maintained these opinions of Augustine. They assumed under Luther a more regular and systematic form than they had ever formerly exhibited. But as the Lutherans afterwards abandoned them, they are now known by the name of *Calvinistic Doctrines*, from John Calvin of Geneva. He asserted, that the everlasting condition of mankind in a future world was determined from all eternity by the unchangeable decree of the Deity, arising from his sole good pleasure or free will. Being a man of great ability, industry, and eloquence, Geneva, where he taught, and which was a free state, soon became the resort of all the men of letters belonging to the reformed churches, and was a kind of seminary from which missionaries issued to propagate the Protestant doctrines through Europe. Their success was such, that, excepting a part of Germany, the principles of all the reformed churches are professedly Calvinistic or Predestinarian.

6
Rise of the
Arminians.

The opponents of the doctrine of predestination among the Protestants usually receive the appellation of *Arminians* or *Remonstrants*. They derive the first of these appellations from James Arminius, who was, A. D. 1602, appointed * professor of theology at Leyden. He was violently opposed by Gomer his colleague, and died A. D. 1609. After his death, the controversy was conducted with great eagerness on both sides. The Calvinists, however, gradually prevailed. A synod was called at Dort, A. D. 1618, to which the most celebrated divines of different countries were invited. There, in a great measure by the authority and influence of Maurice prince of Orange, the Arminians were condemned as heretics; for by this time ambitious and powerful men found themselves politically interested in this religious contest. The Arminians presented to this synod a remonstrance, containing a statement of their faith upon the subjects in dispute; and from this they derived the appellation of *Remonstrants*. This statement contained the following five articles: 1. That God from all eternity predestinated those to everlasting salvation whom he foresaw would believe in Christ unto the end of their lives; and predestinated obstinate unbelievers to everlasting punishment. 2. Jesus Christ died for the whole human race, and for every individual of it, but believers alone reap the benefit of his death. 3. No man can produce faith in his mind by his own free will, but it is necessary that man, who is by nature wicked and unfit for acting or thinking aright, should be regenerated by the grace of the Holy Spirit, imparted by God for Christ's sake. 4. This divine grace constitutes the source, the progress, and the fulfilment, of all that is good in man; but it is not irresistible in its operation. 5. Believers, by the assistance of the Holy Spirit, are abundantly fitted for every good work; but whether it is possible for those who have once been truly such to fall away, and to perish finally, is not clear,

and must be better inquired into by searching the sacred scriptures.

In opposition to these, a counter-remonstrance was presented, containing the opinions of the Calvinists, which was approved of by the synod. The substance of it was afterwards adopted, and in nearly the same expressions, into the Confession of Faith compiled by the assembly of divines which met at Westminster, A. D. 1643, and which every clergyman and probationer for the ministry in Scotland is at present required to subscribe previous to his admission. To give as clear and as fair an idea as possible of the Calvinistic doctrine upon this head, we transcribe the following passage from that Confession: "God from all eternity did, by the most wise and holy counsel of his own will, freely and unchangeably ordain whatsoever comes to pass; yet so, as thereby neither is God the author of sin, nor is violence offered to the will of the creatures, nor is the liberty or contingency of second causes taken away, but rather established. Although God knows whatsoever may or can come to pass upon all supposed conditions; yet hath he not decreed any thing because he foresaw it as future, or that which would come to pass upon such conditions. By the decree of God, for the manifestation of his glory, some men and angels are predestinated unto everlasting life, and others are fore-ordained to everlasting death. These angels and men, thus predestinated and fore-ordained, are particularly and unchangeably designed; and their number is so certain and definite, that it cannot be either increased or diminished. Those of mankind that are predestinated unto life, God, before the foundation of the world was laid, according to his eternal and immutable purpose, and the secret counsel and good pleasure of his will, hath chosen, in Christ, unto everlasting glory, out of his mere free grace and love, without any foresight of faith, or good works, or perseverance in either of them, or any other thing in the creature, as conditions or causes moving him thereunto; and all to the praise of his glorious grace. As God hath appointed the elect unto glory, so hath he, by the eternal and most free purpose of his will, fore-ordained all the means thereunto. Wherefore, they who are elected, being fallen in Adam, are redeemed by Christ, are effectually called unto faith in Christ, by his spirit working in due season; are justified, adopted, sanctified, and kept, by his power through faith unto salvation. Neither are any other redeemed by Christ effectually called, justified, adopted, sanctified, and saved, but the elect only. The rest of mankind, God was pleased, according to the unsearchable counsel of his own will, whereby he extendeth or withholdeth mercy as he pleaseth for the glory of his sovereign power over his creatures, to pass by, and to ordain them to dishonour and wrath for their sin, to the praise of his glorious justice."

There are two kinds of Calvinists or Predestinarians, viz. the *Supralapsarians*, who maintain that God did originally and expressly decree the fall of Adam, as a foundation for the display of his justice and mercy; while those who maintain that God only permitted the fall of Adam, are called *Sublapsarians*, their system of decrees concerning election and reprobation being, as it were, subsequent to that event. But, as Dr Priestley justly remarks, if we admit the divine prescience, there

* *Relatio Historica de Origine et Progressu Controversiarum in Phœderato Belgio de Prædestinatione Pbi. Lipsiæ a Limborch.*

7
Calvinistic doctrine of predestination.

8
Supralapsarians and Sublapsarians.

Predestina-
tion.Disputes in
the church
of Rome on
the subject

is not, in fact, any difference between the two schemes; and accordingly that distinction is now seldom mentioned.

Nor was the church of Rome less agitated by the contest about predestination than the first Protestants were. The council of Trent was much perplexed how to settle the matter without giving offence to the Dominicans, who were much attached to the doctrine of Augustine, and possessed great influence in the council. After much dispute, the great object came to be, how to contrive such a decree as might give offence to nobody, although it should decide nothing. Upon the whole, however, they seem to have favoured the Semi-pelagian scheme. Among other things, it was determined, that good works are of themselves meritorious to eternal life; but it is added, by way of softening, that it is through the goodness of God that he makes his own gifts to be merits in us. Catarin revived at that council an opinion of some of the schoolmen, that God chose a small number of persons, such as the blessed virgin, the apostles, &c. whom he was determined to save without any foresight of their good works; and that he also wills that all the rest should be saved, providing for them all necessary means, but they are at liberty to use them or not. This is called the *Baxterian* scheme in England, from one of its promoters there. But at all events, the council of Trent seems to have been extremely anxious that any opinions entertained among them concerning predestination might have as little influence as possible upon practical morality. "Let no man (say they), while he remains in this mortal state, presume that he is among the number of the elect, and that therefore he cannot sin, or sin without repentance; for it cannot be known who are elected without a special revelation from God." Sef. 6. c. 13.

The Jesuits at first followed the opinion of Augustine; but they afterwards forsook it. *Molina*, one of their order, was the author of what is called the *middle scheme*, or the doctrine of a *grace sufficient for all men*, but subject to the freedom of the human will. *Janse-
nius*, a doctor of Louvain, opposed the Jesuits with great vigour, and supported the doctrine of Augustine. He wrote in a very artful manner. He declared, that he did not presume to state his own sentiments upon

the subject; he pretended only to explain and publish the sentiments of that great father of the church St Augustine. But the Jesuits, in consequence of that inviolable submission to the authority of the pope which they always maintained, had sufficient interest at Rome to procure the opinions of Janse-
nius to be condemned there; but with this addition subjoined, that nothing was thereby intended to be done in prejudice of the doctrine of St Augustine. This produced an absurd dispute about the pope's infallibility in matters of fact. The Janse-
nists affirmed, that the Pope had made a mistake in condemning the opinions of Janse-
nius as different from those of Augustine; whereas in truth they are the same, and the one cannot be condemned without the other. But the Jesuits affirmed, that the pope is no less infallible in points of fact than he is in questions of faith; and he having decided, that the opinions of Janse-
nius are different from those of St Augustine, every good Catholic is bound to believe accordingly that they are different. These disputes have never been fully settled, and still divide the Roman Catholic churches. Some of the ablest supporters of pre-
destination have appeared among the Janse-
nists, and particularly among the gentlemen of Port-Royal.

With regard to Great Britain, the earliest English reformers were in general Sublap-
sarians, although some of them were Supralapsarians. But the rigid Predesti-
narians have been gradually declining in number in that church, although they still subscribe the 39 articles of their faith, which are unquestionably Calvinistic. The celebrated Scotch reformer John Knox having been educated at Geneva, established in this country the doctrine of predestination in its strictest form: and it has probably been adhered to with more closeness in Scotland than in any country in Europe.

Of late years, however, the dispute concerning predestination has assumed a form considerably different from that which it formerly possessed. Instead of being considered as a point to be determined almost entirely by the sacred scriptures, in the hands of a number of able writers, it has in a great measure resolved itself into a question of natural religion, under the head of the philosophical liberty or necessity of the will (A); or, whether all human actions are or are not necessarily determined

(A) Dr Priestley, the most celebrated Necessarian of the age, has written a whole section of his *Illustrations*, with a view to show, that between "the two schemes of Calvinistic predestination and philosophical necessity, there is no sort of resemblance, except that the future happiness or misery of all men is certainly foreknown and appointed by God. In all other respects (says he) they are most essentially different; and even where they agree in the end, the difference in the manner by which that end is accomplished is so very great, that the influence of the two systems on the minds of those that adopt and act upon them is the reverse of one another." The Calvinistic doctrine of predestination, according to a very authentic statement of that doctrine*, is, that "God, for his own glory, hath fore ordained whatsoever comes to pass." The scheme of philosophical necessity, as stated by an intimate friend and warm admirer of Dr Priestley's, is, "That every thing is predetermined by the Divine Being; that whatever has been, must have been; and that whatever will be, must be; that all events are pre-ordained by infinite wisdom and unlimited goodness; that the will, in all its determinations, is governed by the state of mind; that this state of mind is in every instance determined by the Deity; and that there is a continued chain of causes and effects, of motives and actions, inseparably connected, and originating from the condition in which we are brought into existence by the Author of our being." The author or compiler of the same book affirms, "That all motion indeed originates in the Deity; that the Deity is self-moved; that he possesses the singular attribute underived of moving himself." But it is added in the very same paragraph from which this last sentence is quoted, that "the very argument we employ to prove one underived source of motion, and

Predestina-
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English and
Scotch re-
formers
predestina-
rians.* Shorter
Catechism of
the Assem-
bly of Di-
vines at
Westminster.

Predestina-
tion.

terminated by motives arising from the character which God has impressed on our minds, and the train of circumstances amidst which his providence has placed us? We have already discussed this point (see METAPHYSICS) by giving a candid statement of the arguments on both sides of the question. We shall treat the subject of predestination in the same manner, avoiding as far as possible any recapitulation of what has been advanced under the head of *NECESSITY and Liberty*.

II
Points at
issue be-
tween the
predestina-
rians and
their oppo-
nents.

From what has been already said, it will appear that the points chiefly at issue between the parties are the following: First, With what views and purposes did God create the world and frame his decrees concerning mankind? Did he contrive a great unalterable scheme of creation and providence only for the sake of manifesting his own glory and perfections? Or did he first consider the free motions of those rational agents whom he intended to create, and frame his decrees upon the consideration of what they might choose or do in all the various circumstances in which he intended to place them?—The second and following questions are branches of this leading one. Did Christ die for a particular portion of the human race, who shall therefore certainly be saved? or was his death intended as a benefit to all, from which none are excluded excepting those who willingly reject it? Is the divine grace certainly and irresistibly efficacious in all those minds to which it is given? or does its effect depend upon the good use which men may or may not make of it? Can any good action be done without it? Do those who have once received it certainly persevere and obtain eternal salvation? or is it possible for any of them to fall away and perish finally?

12
Arguments
for the doc-
trine

* *Galvini
Respons.
contra Sig-
naum, ad
sum lib.*

WE shall begin by stating the argument on the side of the predestinarians, and in the language which they commonly use. But it is necessary to make this previous remark, that the general* objections to their doctrine are, that it is hostile to all our ideas of the justice of God, representing him as a partial being, rewarding without merit, and punishing without sin; that it renders him the author of evil, destroys moral distinctions, makes useless every effort on our part, makes every prayer absurd, and even the preaching of the gospel vain; seeing that all things are immutably fixed, and none can believe or be saved excepting the elect, and they must certainly and at all events be safe. Against all this they reason thus.

The great and everlasting Author of all things existed from eternity alone, independent and essentially perfect. As there was no other, he could only consider himself and his own glory. He must therefore have designed all things in and for himself. To make him stay his determinations till he should see what free creatures would do, is to make him decree with uncer-

8

tainty, and dependently upon them, which falls short of infinite perfection. He existed alone, and his councils could have no object excepting himself; he could only then consider the display of his own attributes and perfection. In doing this, as the end is more important than the means, Divine Wisdom must begin its designs with that which is to come last in the execution of them; but the conclusion of all things at the last judgment will be the complete manifestation of the wisdom, the goodness, and justice, of God: we must therefore suppose, that, in the order of things, he decreed that first, although with him, in the order of time, there is no first nor second, but all is from eternity. When this great design was laid, the means were next designed. Creation, and its inhabitants of every order, form the means by which the author and disposer of all things accomplishes his will. But creatures in his sight are nothing, and are figuratively said to be less than nothing. We may entertain proud and elevated conceptions of our own dignity if we please; but if we in our designs regard not the dust on which we tread, or the lives of ants and insects, the omnipotent Lord of all, from whom we are more infinitely distant, must regard us as at least equally inconsiderable, and only valuable as we serve the accomplishment of his great and mysterious purposes, which cannot be us or our aggrandisement, but himself and his own glory.

It is only by this view of the divine conduct that some of the attributes of God can be explained, or their existence rendered possible. In the scriptures he claims the attribute of *prescience* as his distinguishing prerogative: but there can be no prescience of future contingencies; for it involves a contradiction to say, that things which are not certainly to be should be certainly foreseen. If they are certainly foreseen, they *must* certainly be, and can therefore be no longer contingent. An uncertain foresight is also an imperfect act, as it may be a mistake, and is therefore inconsistent with divine perfection. On the other side the difficulty is easily explained. When God decrees that an event shall take place, its existence becomes thenceforth certain, and as such is certainly foreseen. For it is an obvious absurdity to say, that a thing happens freely, that is to say, that it may be or may not be, and yet that it is certainly foreseen by God. He cannot foresee things but as he decrees them, and consequently gives them a future certainty of existence; and therefore any prescience antecedent to his decree must be rejected as impossible. Conditional decrees are farther absurd, inasmuch as they subject the purposes of God to the will and the actions of his creatures. Does he will, or wish that all mankind should be saved, and shall they not all be saved? Infinite perfection can wish nothing but what it can execute; and if it is fit to wish, it is also fit to execute its wishes. We are indeed certainly informed by the scrip-

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Divine at-
tributes.

and existence, is a gross solecism in logic; and that the ascription of this power to the Divine Being is in fact nothing else than the less of two palpable *absurdities* or rather *impossibilities*, if these could admit of degrees.†

The piety of these assertions will be obvious, we are persuaded, to every one of our readers; but to some it is possible that their consistency may not be apparent. We would advise all such “to peruse once and again Dr Priestley’s *Illustrations*,” which, we have the best authority to say, will remove from their minds all libertarian prejudices, convince them “that the hypothesis of necessity is incontrovertibly true,” and show them that all the defenders of that hypothesis are in perfect harmony with themselves and with one another!

† *Essay on
Philosophical
Necessity by
Alexander
Grombie,
A. M.*

Predestina-
tion.14
Christ died
on y for
the elect.

scriptures, that all shall not be saved; and we therefore as certainly conclude, that God never intended that they should be so; *for the counsel of the Lord standeth fast, and the thoughts of his heart, to all generations.*

We conclude upon the same principles, that although the blessings resulting from the death of Christ are offered to all, yet that intentionally and actually he only died for those whom the Father had chosen and given to him to be saved by him. That Christ should have died in vain is represented by the apostle Paul as a great absurdity (Gal. ii. 21.): but if he died for all, he must have died in vain with regard to the greater part of mankind who are not to be saved by him. In so far as some inferior blessings are concerned, which through him are communicated, if not to all men, at least to all Christians, he may perhaps justly be said to have died for all: but with regard to eternal salvation, his design, to avoid rendering it fruitless, could go no farther than the secret purpose and election of God. This is implied in these words, *all that are given me of my Father, thine they were, and thou gavest them me.* To these his intercession is limited; *I pray not for the world, but for those that thou hast given me; for they are thine, and all thine are mine, and mine are thine* (Jo. xvii. 9, 10.) Universal words are indeed used with regard to the death of Christ: but the reason is obvious, the Jewish religion was confined to the family and descendants of Abraham. In contradiction to this, the gospel is said to be preached to *every creature, and to all the world*; because it is not limited to any one race or nation, and because the apostles received a general commission to teach it unto all who should be willing to receive it. These extensive expressions can only be understood in this manner, because in their strict acceptance they have never been verified. Nor can their meaning be carried farther without an imputation upon the justice of God: for if he has received a sufficient satisfaction for the sins of the whole world, it is not just that all should not be saved by it, or at least have the offer of salvation made to them, that they may accept of it if they please.

But to return to the divine purposes and attributes in general: it is in vain to assert that God is partial and unjust while he prefers without merit, and predestinates to punishment those who have not yet offended. The same error misleads men here that has so often seduced them from the true path of scientific research. Instead of submitting to the patient and humble observation of nature, they boldly form some plausible hypothesis of their own, and vainly attempt to reconcile every appearance to their favourite system. This mode of procedure never has proved, and never will prove, successful in any branch of true philosophy. We are not entitled to frame to ourselves certain notions of the justice of God, and from these to decide that thus he must act and in no other manner. He takes no counsel from us concerning his conduct, and we have no right to rejudge his judgments. What he regards as just or unjust between himself and his creatures, is a question of fact not to be known by ingenious conjectures, but by the cautious observations of the manner in which he acts in the course of his providence, and by attending to what he has declared concerning himself in the sacred scriptures. If from these it shall appear that he does prefer where there is no merit, and reject where there is no crime; it will

VOL. XV. Part II.

be in vain thereafter to assert that such conduct is unjust: the fact will be on our side of the question, and we shall leave those to account for it who insist that their limited reason is capable of comprehending all the mysterious ways of an Infinite Being.

In the course of providence, then, we see the greatest inequalities take place, and such as appear altogether contradictory to our ideas of justice. We see the sins of the fathers punished in the persons of the children, who often derive debilitated bodies from the intemperance of their parents, and corrupted manners from the example of their vices. God frequently afflicts good men in this life for a great length of time, as in the case of Job, only for the manifestation of his own glory, that their faith and patience may be made manifest. Some sins are punished with other sins, and often with a course of severe miseries in the persons of those who never committed them. We may transfer this from time to eternity; for if God may do for a little time what is inconsistent with our notions, and with our rules of justice, he may do it for a longer duration: since it is as impossible that he can be unjust for a day as for all eternity: and the same inequality of management appears in the great as in the private affairs of this world. During many ages almost the whole human race were lost in the darkness of idolatry: even since the Christian religion came into the world, how few nations have received it; and of these few, the number is still smaller of those who have enjoyed it in tolerable purity. If we consider how many great nations remain under the delusion contrived by Mahomet; if we reflect upon the idolatry of the Indies and of China, and the superstition of the Greek church, and of the church of Rome—we shall find that very few nations have possessed the most ordinary means of grace. Even the blessings of civilization, of science, and of liberty, are so rarely scattered over the face of the earth, that it is to be regarded as a melancholy truth, that with a very few favoured exceptions the whole human race have hitherto been sunk in the depth of barbarism, ignorance, slavery, and idolatry. When the Arminians think fit to assert, then, that the doctrine of absolute decrees is contrary to their ideas of the impartiality and justice of God, we can only answer that we are sorry for them if they have formed ideas of the character of God which are contrary to the truth. We presume not * like them to call his attributes before the tribunal of our understandings; we only observe the ways of his providence, and declare that thus stands the fact. If he leaves whole nations in darkness and corruption, and freely chooses others to communicate the knowledge of himself to them, we need not be surprised if he act in the same manner with individuals. For surely the rejecting immense empires for so many ages is much more unaccountable than the selection of a few individuals, and the leaving others in ignorance and depravity. It is in vain to allege that he extends his mercy to those who make the best use of the dim light which they have. This does not remove the difficulty of a choice and a preference; as it cannot be denied that their condition is very deplorable, and that the condition of others is much more hopeful: so that the mysterious doctrine of election and reprobation is an unquestionable truth under the government of God, seeing that great numbers of men are born in such circumstances that it is morally impossible they should not pe-

Predestina-
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† Uti supra.

rish in them; whereas others are more happily situated and enlightened.

Nor are we left to common observation upon this point. The language of the sacred scriptures is positive and clear. The whole reasoning in the ninth chapter to the Romans resolves all the acts of God's justice and mercy, his *hardening* as well as his *pardon*ing, into an absolute freedom and an unsearchable depth. More pointed expressions for this purpose can scarcely be conceived than those actually made use of. *For the children being not yet born, neither having done any good or evil, that the purpose of God according to election might stand, not of works, but of him that calleth, it was said, The elder shall serve the younger. As it is written, Jacob have I loved, but Esau have I hated. What shall we say then? Is there unrighteousness with God? God forbid. For he saith to Moses, I will have mercy on whom I will have mercy, and I will have compassion on whom I will have compassion. So then it is not of him that willeth, nor of him that runneth, but of God that sheweth mercy; for the scripture saith unto Pharaoh, Even for this same purpose have I raised thee up, that I might show my power in thee, and that my name might be declared throughout all the earth. Therefore hath he mercy on whom he will have mercy, and whom he will he hardeneth.* If any man shall still be sufficiently bold to declare that all this is contrary to what he is pleased to consider as just and impartial, we can only reply to him in the words of the celebrated John Calvin of Geneva †. *Tibi molestum est ac odiosum, Deum plus posse et facere, quam mens tua capiat; æquali autem tuo interdum concedes, ut suo judicio fruatur. Et tu in tanto furore, Dei mentionem ullam facere audes?* "Is it painful to thee that the power and the works of God exceed thy limited capacity? Thou sometimes sufferest thine equal to judge of his own conduct for himself, and darest thou in thy folly to censure the ways of God?" Or rather we may reply in those words of the apostle Paul which immediately follow the passage already quoted. *Thou wilt say then to me, Why doth he yet find fault? for who hath resisted his will? Nay but, O man, who art thou that repliest against God? Shall the thing formed say to him that formed it, Why hast thou made me thus? Hath not the potter power over the clay; of the same lump to make one vessel unto honour, and another unto dishonour?* Let these passages, and even the whole of the chapter now alluded to, be explained in any manner that is judged proper, still their import with regard to the present argument will remain the same. If God loved Jacob so as to chuse his posterity to be his people, and rejected or hated Esau and his posterity, and this without regard to them or their future conduct, but merely in consequence of the purpose and design of his election; if by the same purpose the Gentiles were to be grafted upon that stock from which the once favoured Jews were cut off; it will follow, not only that the great and mysterious decree of final election is unsearchably free and absolute, but also that all the means of grace are granted or withheld in the same unlimited and free manner according to the sovereign will and good pleasure of God, independent of any foresight of merit on our part. The words of our Saviour express this: *I thank thee O Father, Lord of heaven and earth, because thou hast hid these things from the wise and prudent, and hast revealed them unto babes:* The reason of which is given in the following words, *Even so, Father, for so it seemed good in thy sight,* (Mat. xi. 26). The passage immediately preceding this, shows clearly that the

means of grace are not bestowed upon those who, it is foreseen, will make a good use of them; nor denied to those who will make a bad use of them. *Wo unto thee Chorazin, wo unto thee Bethsaida: for if the mighty works which were done in you had been done in Tyre and Sidon, they would have repented long ago in sackcloth and ashes.* But the passages in scripture are innumerable, which declare that the whole character and destiny of every man is the result of the counsel and uncontrouled determination of God. The expression is often repeated in the book of Exodus; *God hardened the heart of Pharaoh, so that he would not let his people go,* (Exod. iv. 21), &c. It is said, that *God has made the wicked man for the day of evil,* (Prov. xvi. 4). On the other hand, it is said, *as many believed the gospel as were appointed to eternal life,* (Acts i. 48.) Some are said to be *written in the book of life, of the Lamb slain from the foundation of the world* (Rev. xiii. 8.) Every prayer that is used, or directed to be used, in scripture, is for a grace that opens our eyes, that turns the heart, that makes us to go, that leads us not into temptation, but delivers us from evil. All these expressions denote that we desire more than a power or capacity to act, such as is given to all men. Indeed we do not, and we cannot, pray earnestly for that which we know all men as well as ourselves possess at all times.

The *grace of God* is the medium by which his sovereign will and absolute decrees are accomplished. Accordingly, it is set forth in scripture by such expressions as clearly denote its sure efficacy; and that it does not depend upon us to use it or not at our pleasure. It is said to be a creation; *we are created unto good works, and we become new creatures:* It is called a regeneration, or a *new birth*; it is called a quickening and a resurrection, as our former state is compared to a feebleness, a blindness, and a death. God is said to *work in us both to will and to do:* *His people shall be willing in the day of his power: He will write his laws in their hearts, and make them to walk in them.* In a passage already quoted, the human race are compared to a mass of *clay* in the hands of the *potter*, who of the same lump makes at his pleasure *vessels of honour and dishonour.* These passages, and this last more particularly, prove that there is an absolute and a conquering power in divine grace; and that the love of God constrains us, as St Paul expresses himself. Our Saviour compares the union and influence that he communicates to believers to the union of an head with the members, and of a root with the branches, which imparts an internal, a vital, and an efficacious influence. The outward means may indeed be rejected, but this overcoming grace never returns empty: these outward means coming from God, the resisting of them is said to be the *resisting of God*, the *grieving or quenching of his spirit*; and in that sense we may resist the grace or favour of God; but we can never withstand him when he intends to overcome us; *For the foundation of God standeth sure, having this seal, The Lord knoweth them that are his,* (2 Tim. ii. 19.) *Having predestinated us unto the adoption of children by Jesus Christ himself, according to the good pleasure of his will,* (Eph. i. 5.)

That the saints shall certainly persevere unto the end is a necessary consequence of absolute decrees and of efficacious grace: all depends on God. *He of his own will begat us; and with him there is no variableness nor shadow of turning: whom he loves, he loves to the end:* and he has promised that he will never leave nor forsake those to whom he becomes a God. Our Lord hath

Predestina-
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hath said, *I give unto them eternal life, and they shall never perish; neither shall any pluck them out of my hand,* (Jo. x. 28.) Hence we must conclude, that *the purpose and calling of God is without repentance,* (Heb. xiii. 5.) And therefore, although good men may fall into great sins, yet of all those who are given by the Father to the Son to be saved by him, none are lost: The conclusion from the whole is, that God did in himself, and for his own glory, *foreknow* a determinate number in whom he would be both sanctified and glorified. These he *predestinated* to be holy, conformable to the image of his son: they are to be *called*, not by a general calling in the sense of these words, *many are called, but few are chosen*; but to be *called according to his purpose*. He *justified* them upon their obeying that calling, and in the conclusion he will *glorify* them; for nothing can separate us from the love of God in Christ, (Rom. ix. 19.) And he is not less absolute in his decree of reprobation than he is in his election: for *ungodly men* are said to be *of old ordained to condemnation, and to be given up by God unto vile affections, and to be given over by him to a reprobate mind.*

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Arguments
against the
doctrine
from the
attributes
of God.

Thus far we have defended the doctrine of predestination: we proceed next to state the arguments usually adduced in favour of the Arminian system.

God is just, holy, and merciful. In speaking of himself in scripture, he is pleased to make appeals to the human understanding, and to call upon men to reason with him concerning his ways. The meaning of this is, that men may examine his actions and his attributes with that measure of intelligence which they possess, and they will be forced to approve of them; nay, he proposes himself to us as a pattern for our imitation. We are required to be holy as he is holy, and merciful as he is merciful: which is a proof that he accounts us not incapable of forming just notions at least of these attributes. What then can we think of a justice that shall condemn us for a fact that we never committed? that designs first of all to be glorified by our being eternally miserable, and which afterwards decrees that we shall commit sins to justify this previous decree of our reprobation? For if God originally designs and determines all things, and if all his decrees are certainly effected, it is inconceivable how there should be a justice in punishing that which he himself, by an antecedent and irreversible decree, appointed to be done. Or, setting justice aside, is it possible that a being of infinite holiness, and who is *of purer eyes than to behold iniquity*, would by an antecedent decree fix our committing so many sins, in such a manner that it is not possible to avoid them? He represents himself in the scriptures as *gracious, merciful, slow to anger, and abundant in goodness and truth*. It is often said, that *he desires that no man should perish, but that all should come to the knowledge of the truth*: this is even said with the solemnity of an oath, *As I live, saith the Lord, I take no pleasure in the death of sinners*. What sense can these words bear if we believe that God did by an absolute decree doom so many of them to everlasting misery? If all things that happen arise out of the absolute decree of God as their first cause, then we must believe that God takes pleasure both in his own decrees and in the execution of them, consequently that *he doth take pleasure in the death of sinners*; and this in express contradiction to the most positive language of scrip-

ture. Besides all this, what are we to think of the truth of God, and of the sincerity of those offers of grace and mercy, with the exhortations and expostulations upon them that occur so frequently in scripture, if we can imagine that by antecedent acts he determined that all these should be ineffectual? In one word, are we to regard our existence as a blessing, and to look up with gratitude to that paternal goodness which has placed us in a *land of hope*, which formed our nature, weak indeed and exposed to many imperfections, but capable of rising by virtuous efforts and by a patient continuance in well-doing to excellence and to high and immortal felicity? or, are we to curse the hour in which we were born under the dominion of a master, who is not only severe, but absurd, and even adds insult to cruelty; who, after placing us in a goodly habitation, binds us hand and foot, locks the door, blocks up the windows, sets fire to the fabric, and then very mercifully calls upon us to come forth lest we perish?

It is not true that rational beings are nothing in the sight of their Maker. Compared to his Almighty strength and uncreated existence, our powers do indeed diminish into weakness, and our years into a moment: yet although our interests may be unimportant in themselves, the attributes of God with which they are connected are far from being so. There was no necessity for his calling us into existence; but the instant he bestowed upon us that gift, and conferred upon us faculties capable of rising to happiness by the contemplation of himself and of his works, he became our parent, and granted to us a right to look up to him for protection and mercy, and to hope that our existence and our faculties were not bestowed in vain. Nor will he trample upon the just and reasonable hopes of the meanest of his creatures. He is watchful over our interests; he hath sent his Son to die for us; his providence has been exerted for no other purpose but to promote our welfare; and there is joy in heaven even over one sinner that repenteth. Let it be allowed, that the universe was formed for no other purpose but to promote the glory of God; that glory can surely be little promoted by the exertion of undistinguishing and blind acts of power, in the arbitrary appointment to eternal reprobation of millions of unresisting and undeserving wretches*. Is it not more honourable to the Deity to con-

* Correspondence between the Deity and the creature, as in the case of the Priest-ly.

It is true that, setting aside predestination, it is not easy to show how future contingencies should be

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The difficulty of
prescience
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Predestina-
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certainly foreseen ; but it is obvious that such foresight involves no contradiction, (see METAPHYSICS, n^o 308) ; and if the actions of men be free, we know from the train of prophecies, which in the sacred scriptures appear to have been made in one age and fulfilled in another, that contingencies are foreseen by that infinite Being who inhabiteth eternity, and to whom a thousand years are but as one day. The prophecies concerning the death and sufferings of Christ were fulfilled by the free acts of the Jewish priests and people : These men sinned in accomplishing that event, which proves that they acted with their natural liberty. From these and all the other prophecies both in the old and new Testament, it must be confessed that future contingencies were certainly foreknown, but where to found that certainty cannot be easily resolved. We doubt not, however, that we may safely refer it to the infinite perfection of the Divine mind. And it ought to be observed that this difficulty is of a very different nature from that to which our antagonists are reduced on their side of the argument. They are compelled to confess that they cannot reconcile their doctrine with the justice of God, an attribute the nature of which we clearly understand, and which is held forth to our imitation ; whereas we are only at a loss how to explain the mode in which the divine prescience is exerted ; an attribute which God claims as peculiarly his own, and which it is not to be expected that we should be able in the smallest degree to comprehend. We can go farther than this. Heaven hath given to man two revelations of itself. The one consists in the knowledge which we procure by the right use of our rational faculties ; and the other is bestowed by means of the sacred scriptures. Without intending to derogate from the authority of inspiration, it is fair to assert, that we are *more certain* that God is the author and bestower of our reason, than that he is the author of the scriptures ; at least it is certain that the last cannot contradict the first, because God cannot contradict himself. By the primary revelation from heaven then, that is, by our reason, we are informed that God is true, and just, and good. If an angel from heaven should preach a doctrine contrary to this, we are entitled to say with the apostle, *let him be accursed*. If our antagonists then should succeed in proving that the doctrine of absolute decrees, which represents the Deity as cruel and unjust, is contained in scripture, the consequence would be, not that we would believe it, for that is impossible, but that we should be reduced to the necessity of rejecting the authority of the scriptures, because they contradict the previous sure revelation of God, our reason. We believe that the doctrines contained in the scriptures are certainly true, because they were taught by those who wrought miracles and foretold future events in proof of their being inspired by the God of truth. But miracles and prophecy are *direct* evidences of nothing but the *power* and *wisdom* of their Author ; and unless we know by other evidence, that this powerful and wise Being is likewise the father of truth and justice, we cannot be sure that the scriptures, notwithstanding their source, are any thing better than a tissue of falsehoods. The very arguments therefore by which predestination is supported, tend to sap the foundation of that revelation from which its advocates pretend to draw them. The case is very different when no doctrine is asserted that is not con-

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tradictory to our reason, but only above it. For example, when we are told that God can create rational beings, that he attends without distraction to the minutest affairs that pass in a thousand worlds, that he knows all things, the past, the present, and the future, we do not presume that we comprehend how he can do all this : but there is nothing in it that contradicts our reason ; we ourselves possess a certain degree of power, can attend at once to a certain number of objects, can in some cases form very sure conjectures about futurity, and we resolve all the rest into the infinite nature and perfections of God.

It is farther to be observed, that prescience does not make effects certain because they are foreseen ; but they are foreseen because they are to be : so that the certainty of the prescience is not the cause, but the consequence of the certainty of the event. The Roman republic has fallen ; but our knowledge or ignorance of that event does not render it more or less true and certain. That it was to fall, was as surely true before it happened as it is now ; and had we known it beforehand, as many men of sense probably did, it would neither have fallen sooner nor later on that account. This shows that the knowledge which an intelligent being has of a past or future event need not have any influence upon the circumstances that produce that event.

On some occasions the scripture takes notice of a conditional prescience *. God answered David, that Saul would come to Keilah, and that the men of Keilah would deliver him up : yet both the one and the other rested upon the condition of his staying there ; and he going from thence, neither of them ever happened. Such also was the † prophecy of Jonah, at the failure of which he was so absurdly offended : and such was Christ's saying, That those of Tyre and Sidon, Sodom and Gomorrah would have turned to him, if they had seen the miracles that he wrought in the towns of Galilee. Since, then, this prescience may be so certain that it can never err nor mislead the exertions of providence, and since by this, both the attributes of God are vindicated, and the due freedom of man is asserted, all difficulties seem to be thus easily removed.

With regard to the purpose of Christ's death, he is said to be the *propitiation for the sins of the whole world* ; for the and the wicked are said to *deny the Lord that bought them*. His death, as to its extent, is set in opposition to the sins of *Adam* ; so that as by the offence of one judgment came upon all men to condemnation, so by the righteousness of one the free gift came upon all men to justification of life, (Rom. v. 18.) The *all* on the one side must be as extensive as the *all* on the other : so, since *all* are concerned in Adam's sin, *all* must likewise be concerned in the death of Christ. To this we may add, that *all* men are commanded and required to believe that Christ died for their sins ; but no man can be obliged to believe what is not true : he must therefore have died for *all*. The following passages express clearly the universality of the object of Christ's death. *If any man sin, we have an advocate with the Father, Jesus Christ the righteous : and he is the propitiation for our sins : and not for ours only, but also for the sins of the whole world, (1 Jo. ii. 1, 2.) The love of Christ constraineth us ; because we thus judge, that if one died for all, then were all dead : and that he died for all, that they which live should*

23
Conditional
prescience.
* 1 Sam.
xxiii. 11,
12.

† Chap. iii.
4.

24
Christ died
whole
world.

Predestina-
tion.25
Freedom
essential to
moral a-
gents.

Should not henceforth live unto themselves, (2 Cor. v. 14.) God so loved the world that he gave his only begotten Son, that whosoever believeth in him might not perish, but might have everlasting life, (Jo. iii. 16.)

But a proper attention to the nature of man will set the justice of our argument in a still stronger point of view. It is obvious, that such an inward freedom as renders a man the master of his own conduct, and able to do or not do what he pleases, is so necessary to the morality of our actions, that without it they are neither good nor evil, neither capable of rewards nor punishments. Madmen, or men asleep, are not to be charged with the good or evil of what they do; therefore at least some small degree of liberty must be left us, otherwise why are we praised or blamed for our conduct? All virtue and religion, all discipline and industry, arise out of this as their first principle, that there is a power in us to govern our own thoughts and actions, and to raise and improve our faculties. If this is denied, all efforts, all education, all attention bestowed upon ourselves or others, become fruitless and vain. If a man accounts himself under an inevitable decree, as he will have little remorse for the evil he does while he imputes it to that inevitable force that constrains him, so he will naturally conclude that it is to no purpose for him to struggle with impossibilities. Men are sufficiently inclined to throw all censure off from themselves, and to indulge in indolence; and upon the doctrine of absolute predestination who can blame them, seeing that their efforts can be of no value?

26
Liberty or
necessity a
quest. on
of fact.

Matter is inactive of itself, and only moves in consequence of its being acted upon by some other being. Man is possessed of a power to begin motion, and to determine it in any direction that he may judge proper. This power and this intelligence constitute his liberty, and form that image of God that is stamped upon his nature. Whether man possesses this power of acting originally and of himself, or whether he is incapable of forming any resolution, or making any effort, without being acted upon by a foreign cause, is not a point to be reasoned on or disputed about: it is a question of fact, which, as far as it can possibly be known, every man has it in his power to determine by the evidence of his own consciousness. We do aver, then, that every man is conscious that he is a free agent, and that it is not possible for the most staunch predestinarian that has ever yet appeared seriously and practically to convince himself of the contrary. It is not possible for a man in his senses to believe, that in all those crimes which men charge *themselves* with, and reproach *themselves* for, God is the agent; and that, properly speaking, they are no more agents than a sword is when employed to commit murder. We do indeed, on some occasions, feel ourselves hurried on so impetuously by violent passions, that we seem for an instant to have lost our freedom; but on cool reflection we find, that we both might and ought to have restrained that heat in its first commencement. We feel that we can divert our thoughts, and overcome ourselves in most instances, if we set seriously about it. We feel that knowledge, reflection, and proper society, improve the temper and disposition; and that ignorance, negligence, and the society of the worthless and abandoned, corrupt and degrade the mind. From all this we conclude, that man is free, and not under inevitable fate, or irresistible motions to good or

evil. This conclusion is confirmed by the whole style of scripture, which upon any other supposition becomes a solemn and unworthy mockery. It is full of persuasions, exhortations, reproofs, expostulations, encouragements, and terrors. But to what purpose is it to speak to dead men, to persuade the blind to see, or the lame to run? If we are under impotence till the irresistible grace comes, and if, when it comes, nothing can withstand it, what occasion is there for these solemn discourses which can have no effect? They cannot render us inexcusable, unless it were in our power to be improved by them; and to imagine that God gives light and blessings, which can do no good, to those whom he before intended to damn, only to make them more inexcusable, and for the purpose of aggravating their condemnation, gives so strange an idea of his character as it is not fit to express in the language that naturally arises out of it.

Our antagonists seem to have formed ideas of the divine perfection and sovereignty that are altogether false. There is no imperfection implied in the supposition that some of the acts of God may depend upon the conduct of his creatures. Perfection consists in forming the wisest designs, and in executing them by the most suitable means. The author of nature conducts the planets in their orbits with immutable precision according to fixed rules: but it would be absurd to pretend to manage free agents, or their affairs, in the same manner by mathematical or mechanical principles. The providence that is exerted over material objects is fixed and steady in its operations, because it is fit that material objects which cannot move of themselves should be moved in a regular manner: but free and intelligent beings enjoy a wider range, and ought not to be confined to a prescribed train of exertions; it may therefore be necessary that the providence which superintends them should accommodate itself to circumstances. This, however, is not injurious to the divine sovereignty; for God himself is the author of that freedom of agency which he is pleased to watch over. He is not less the Lord of the universe; and surely his wisdom and benevolence are more conspicuous when he brings good out of evil, and renders the perverse wanderings of the human heart subservient to purposes of mercy, than when he hurls into the immensity of space the most enormous mass of dead and passive matter subjected to unerring laws.

As for the inequalities of moral situation that are to be observed in the world, and the giving to some nations and persons the means of improvement, and the denying them to others, the scriptures do indeed ascribe these wholly to the riches and freedom of God's grace. And, we confess, that the ways of Providence are often dark and mysterious. In this world there are many things which are hard to be understood, and many which appear altogether unaccountable; we see the wicked man prospering in his wickedness, though it impose misery upon thousands; we see truth hiding its head, and the world governed by fraud and absurdity. Still, however, we can venture to assert, that God bestows upon all what is necessary to enable them to fulfil the obligations expected from the state in which they are placed; and it is elsewhere shown, that physical evil is among men the parent of moral good. (See PROVIDENCE). God winketh at the times of ignorance; much

Predestina-
tion.27
Some of
the acts of
God de-
pend on
the conduct
of his crea-
tures.28
The ine-
qualities of
Providence
accounted
for.

Predesti-
nation.

much is required of them to whom much is given; and it shall be more tolerable in the day of judgment for the inhabitants of Sodom and Gomorrah than for the enlightened cities of Galilee. Thus God will be just when he judges; none will meet with condemnation excepting those who are inexcusable. For although he grants more to some than may be absolutely necessary, yet he grants less to none; and where he grants little, he will suit his judgments to the little which he gave. There is no injustice in this. If it was the intention of the great Creator that his creation should contain within its ample bosom every possible variety of intelligent natures, it was necessary that there should be somewhere such a being as man; and, in forming all possible varieties of human minds and situations, it was necessary that every particular individual should exist. Hence a man may as well complain that he was not formed one of the flaming seraphims that surround the throne of the Eternal, as that he is not placed in other circumstances in life than those which he now occupies; for if little is given, little will be required from him. Thus the designs of Providence go on according to the goodness and mercy of God. None can complain, though some have more cause for joy than others. What happens to individuals may happen to nations in a body; some may have higher privileges, and be placed in happier circumstances than others; but none can complain of the wise and just disposer of all, who has given enough, although we may have good reason to complain of ourselves, for not using what was sufficient.

As to the case of those who are not blessed with the light of the gospel, we may consider, that if they have fewer and less advantages than others, their nature and capacities must likewise be inferior; to which their future state may be proportioned. God is not obliged to make all men equally perfect in the next world any more than in this; and if their capacity be rendered less than that of an ordinary *Christian*, a lower degree of happiness may fill it. However, we need not be extremely solicitous about their state, much less cast any ungrateful imputations on the Governor of the world for not having dealt so bountifully with them as he has with ourselves; since we know that Christ died for the whole race of mankind; that every one will at length be 'accepted according to that he has, and not according to that he has not; and that to whomsoever much is given, of him shall much be required' (B).

29
Scriptural
expressions
explained.

Upon these principles, we can easily explain all the passages in the New Testament concerning the *purpose*, the *election*, the *foreknowledge*, and the *predestination* of God. They relate to the design of calling the Gentile world to the knowledge of the Messiah: This was kept secret, though hints had been given of it by several of the prophets, so that it was a mystery; but it was revealed when the apostles, in consequence of Christ's commission, *to go and teach all nations*, went about preaching the gospel to the Gentiles. This was a stumbling-block to the Jews, and it was the chief subject of dispute betwixt them and the apostles at the

time when the Epistles were written: so that it was necessary for them to clear up this point very fully, and to mention it frequently. But in the beginning of Christianity there was no need of amusing men with high and unsearchable speculations concerning the decrees of God; the apostles therefore take up the point in dispute, the calling of the Gentiles in a general manner. They show, that Abraham at first, and Isaac and Jacob afterwards, were chosen by a discriminating favour, that they and their posterity should be in covenant with God; but that, nevertheless, it always was the intention of Providence to call in the Gentiles, though it was not executed till these later times.

Predesti-
nation.

With this key we can explain coherently the whole of St Paul's discourses upon this subject, without asserting antecedent and special decrees as to particular persons. Things that happen under a permissive and directing Providence, may, by a largeness of expression, be ascribed to the will and counsel of God; for a permissive will is really a will, though it is not the agent or cause of the effect. The *hardening of Pharaoh's heart* may be ascribed to God, though it is said that his *heart hardened itself*, because he took advantage of the respite which God granted him from the plagues, to encourage himself to longer resistance. Besides this, he was a cruel and bloody tyrant, and deserved such judgments for his other sins; so that he may be considered as at that time under final condemnation, and only preserved from the first plagues, to afford a striking instance of the avenging justice of God. That this is the meaning of the passage, appears extremely probable from the manner in which Exod. ix. 16. is rendered in the Vatican and Aldus's edit. of the LXX. Instead of saying, as in our translation, "And in very deed for this cause have I raised thee up, for to show in thee my power, &c." God is represented in that version as saying, "And in very deed for this cause have I kept thee alive till now, for to show," &c. *Whom he will he hardeneth*, is an expression that can only be applied to such persons as this tyrant was. It is obvious that the words of our Saviour concerning those *whom his Father had given him*, are only meant of a dispensation of Providence, and not of a decree; since he adds, *And I have lost none of them except the son of perdition*: for it cannot be said that Judas Iscariot was in the decree, and yet was lost. And in the same passage in which God is said *to work in us both to will and to do*, we are required *to work out our own salvation with fear and trembling*. The word *ordained* to eternal life also signifies fitted and disposed to eternal life. The question, *Who made thee to differ?* (1 Cor. iv. 7.) refers to those extraordinary gifts which, in different degrees and measures, were bestowed upon the first Christians, in which they were unquestionably passive.

If the decrees of God are not absolute, neither can³⁰ his grace be so efficacious as absolutely and necessarily irresistible. to determine our conduct, else why are we required *not to grieve God's spirit?* why is it said, *ye do always resist the Holy Ghost; as your fathers did, so do ye?* How often

(B) See Bishop Law's *Considerations on the Theory of Religion*, where this question is treated in a very masterly manner. The work, though less known than it ought to be, has great merit, and of the author we have given a biographical sketch in our ninth volume.

Predestina- *often would I have gathered you under my wings, and ye*
tion. *would not? What could I have done in my vineyard that*
has not been done in it? These expressions indicate a
 power in us, by which we not only can, but often do,
 resist the motions of grace. But if the determining
 efficacy of grace is not acknowledged, it will be much
 harder to believe that we are efficaciously determined to
 sin. This supposition is so contrary both to the holi-
 ness of God, and to the whole style of the sacred writ-
 ings, that it is unnecessary to accumulate proofs of it.
O Israel, thou hast destroyed thyself, but in me is thy help :
ye will not come unto me that ye may have life : Why will
you die, O house of Israel?

31
 The great-
 est faint on
 earth may
 fall.

As for perseverance, we may remark, that the ma-
 ny promises made in the sacred scriptures to them
 that *overcome*, that continue *stedfast and faithful to the*
death, do certainly insinuate that a man may fall from
 a good state. The words of the apostle to the Hebrews
 are very clear and pointed: *For it is impossible for those*
who were once enlightened, and have tasted of the heavenly
gift, and were made partakers of the Holy Ghost, and
have tasted the good word of God, and the powers of the
world to come, if they shall fall away, to renew them again
unto repentance (Heb. vi. 4.) It is also said, *The just shall*
live by faith : but if he draw (c) back, my soul shall have
no pleasure in him, (Heb. x. 38.) And it is said by the
 prophet, *When the righteous turneth away from his righte-*
ousness, and committeth iniquity, all his righteousness that
he hath done shall not be mentioned ; in his sin that he hath
sinned shall he die, (Ezek. viii. 24.) These passages, with
 many others, give us every reason to believe that a
 good man may fall from a good state, as well as that a
 wicked man may turn from a bad one.

32
 All diffi-
 culties
 solved at
 at the day
 of judge-
 ment.

We conclude the whole by observing, that the on-
 ly difficulty which attends the question arises from the
 mysterious, and apparently partial and unequal, course
 of the divine government in our present state ; but
 there is an important day approaching, when God will
 condescend to remove these obscurities, and to vindicate
 the ways of his providence to man. On that great day,
 we are well assured, that the question will be decided
 in our favour ; for we know that judgment will be giv-
 en, not according to any absolute decree, but accord-
 ing to the deeds which we ourselves shall have freely
 done in the body, whether they have been good, or whe-
 ther they have been evil.

Thus have we stated, we hope with fairness and im-
 partiality, a summary of the arguments on both sides of
 this long agitated question. We need hardly add, that
 it is a question involved in considerable difficulties.—
 Milton, who was an eminent philosopher and divine,
 as well as the first of poets, when he wished to exhibit
 the fallen angels themselves as perplexed by questions
 above their comprehension, set them to dispute about
 predestination.

They reason'd high, of knowledge, will, and fate,
 Fixed fate, free-will, fore-knowledge absolute ;
 And found no end, in wand'ring mazes lost.

Paradise Lost.

The weak side of the Calvinistic doctrine consists in the impossibility of reconciling the absolute and uncon-
 ditional decree of reprobation with our ideas of the
 justice and goodness of God. The weak side of the
 Arminian scheme consists in the difficulty of account-
 ing for the certainty of the divine foreknowledge, upon
 the supposition of a contingency of events, or an abso-
 lute freedom of will in man.

Predestina-
tion
 ||
Predial.
 33
 The weak
 side of each
 doctrine.

To elude the former of these difficulties, some of the
 late writers upon philosophical necessity, and Dr Priest-
 ly is among the number, have given up the doctrine of
 reprobation, and asserted, that this world is only a state
 of preparation for another, in which all men, of every
 description and character, shall attain to final and ever-
 lasting happiness, when *God shall be all, and in all.*—
 On the other side, some of the supporters of free agen-
 cy, and Montesquieu * is among the number, have been
 disposed to deny the divine attribute of presci-
 ence.

Whatever may be thought of the practical tendency
 of the two opinions, there is one remark which we think
 ourselves bound in justice to make, although it ap-
 pears to us to be somewhat singular. It is this, that
 from the earliest ages down to our own days, if we con-
 sider the character of the ancient Stoics, the Jewish Es-
 senes, the modern Calvinists, and Jansenists, when com-
 pared with that of their antagonists the Epicureans, the
 Sadducees, Arminians, and the Jesuits, we shall find that
 they have excelled in no small degree in the practice of
 the most rigid and respectable virtues, and have been the
 highest honour of their own ages, and the best models
 for imitation to every age succeeding. At the same time,
 it must be confessed, that their virtues have in general
 been rendered unamiable by a tinge of gloomy and se-
 vere austerity.

So far as the speculative foundation of their princi-
 ples is considered, however, neither party seems liable to
 censure in a moral point of view. Each of them wishes
 to support, though in a different manner from the other,
 the honour of the divine character. The Calvinists be-
 gin their argument with the notion of infinite perfec-
 tion, independency, and absolute sovereignty, and thence
 deduce their opinions ; making every difficulty yield to
 these first and leading ideas. Their opponents are

34
 Mutual for-
 bearance
 of justice, truth, holiness, and mercy, and deduce their recom-
 mendations from the idea which they have formed of
 these. Each party lays down general maxims that are
 admitted by the other, and both argue plausibly from
 their first principles. Dr Burnet, whom we have
 here followed very closely, justly observes †, that
 “ these are great grounds for mutual charity and for-
 bearance.”

PREDETERMINATION, in philosophy and the-
 ology, is that concurrence of God which makes men act,
 and determines them in all their actions, both good and
 evil, and is called by the schoolmen *physical predetermi-*
nation or premotion. See METAPHYSICS, Part III.
 Chap. v. and PREDESTINATION.

† Exposition
 of the 39
 Articles.

PREDIAL SLAVES. See *Predial-SLAVES.*

PRE-

(c) In our translation we read, “ If any man draw back,” &c. ; but the words *any man* are not in the origi-
 nal ; and if they do not make nonsense of the text, they must at least be acknowledged to obscure its meaning.

Predial
||
Pre-existence.

PREDIAL-TUBES, are those that are paid of things arising and growing from the ground only; as corn, hay, fruit, &c.

PREDICABLE, among logicians, denotes a general quality which may be predicated, or asserted of several things: thus animal is predicable of mankind, beasts, birds, fishes, &c.

PREDICAMENT, among logicians, the same with category. See **CATEGORY** and **PHILOSOPHY**.

PREDICATE, in logic, that which, in a proposition, is affirmed or denied of the subject. In these propositions, *snow is white, ink is not white*; whiteness is the predicate which is affirmed of snow, and denied of ink.

PRE-EMPTION, a privilege anciently allowed the king's purveyor, of having the choice and first buying of corn and other provisions for the king's house; but taken away by the statute 19 Car. II.

PREENING, in natural history, the action of birds cleaning, composing, and dressing their feathers, to enable them to glide more easily through the air. For this purpose they have two peculiar glands on their rump, which secrete an unctuous matter into a bag that is perforated, out of which the bird occasionally draws it with its bill.

PRE-EXISTENCE, a priority of being, or the being of one thing before another. Thus a cause, if not in time, is yet in nature pre-existent to its effect. Thus God is pre-existent to the universe. Thus a human father is pre-existent to his son. The Peripatetics, though they maintained the eternity of the world, were likewise dogmatical in their opinion, that the universe was formed, actuated, and governed, by a sovereign intelligence. See *Aristotle on the Soul*, and our articles **CREATION** and **EARTH**. See also the *Philosophical Essays of Dr Isaac Watts*, and the *Principles of natural and revealed Religion*, by the Chevalier Ramsay, where the subject of the world's eternity is discussed. Mr Hume's speculations also, on this abstruse and arduous subject, had a greater tendency to dissipate its gloom than that philosopher himself could imagine.

The pre-existence of the human soul to its corporeal vehicle had been from time immemorial a prevailing opinion among the Asiatic sages, and from them was perhaps transferred by Pythagoras to the philosophy of the Greeks; but his metempsychosis, or transmigration of souls, is too trivial either to be seriously proposed or refuted. Nevertheless, from the sentiments of Socrates concerning the immortality of the soul, delivered in his last interview with his friends, it is obvious that the tenet of pre-existence was a doctrine of the Platonic school. If at any period of life, say these philosophers, you should examine a boy, of how many ideas, of what a number of principles, of what an extent of knowledge, will you find him possessed: these without doubt could neither be self-derived nor recently acquired. With what avidity and promptitude does he attain the knowledge of arts and sciences, which appear entirely new to him! these rapid and successful advances in knowledge can only be the effects of reminiscence, or of a fainter and more indistinct species of recollection. But in all the other operations of memory, we find retrospective impressions attending every object or idea which emerges to her view; nor does she ever suggest any thought, word, or action, without

informing us, in a manner equally clear and evident, that those impressions have been made upon our senses, mind, or intellect, on some former occasion. Whoever contemplates her progress, will easily discover, that association is her most faithful and efficacious auxiliary; and that by joining impression with impression, idea with idea, circumstance with circumstance, in the order of time, of place, of similarity or dissimilarity, she is capacitated to accumulate her treasures and enlarge her province even to an indefinite extent. But when intuitive principles, or simple conclusions, are elicited from the puerile understanding by a train of easy questions properly arranged, where is the retrospective act of memory, by which the boy recognises those truths as having formerly been perceived in his mind? Where are the crowds of concomitant, antecedent, or subsequent ideas, with which those recollections ought naturally to have been attended? In a word, where is the sense of personal identity, which seems absolutely inseparable from every act of memory? This hypothesis, therefore, will not support pre-existence. After the Christian religion had been considerably diffused, and warmly combated by its philosophical antagonists, the same doctrine was resumed and taught at Alexandria, by Platonic proselytes, not only as a topic constituent of their master's philosophy, but as an answer to those formidable objections which had been deduced from the doctrine of original sin, and from the vices which stain, and from the calamities which disturb, human life: hence they strenuously asserted, that all the human race were either introduced to being prior to Adam, or pre-existent in his person; that they were not, therefore, represented by our first parents, but actually concurred in their crime, and participated their ruin.

The followers of Origen, and such as entertained the notion of Pre-adamites*, might argue from the doctrine of pre-existence with some degree of plausibility. For the human beings introduced by them to the theatre of probation had already attained the capacity or dignity of moral agents; as their crime therefore was voluntary, their punishment might be just. But those who believe the whole human race created in Adam to be only pre-existent in their germs or stamina, were even deprived of this miserable subterfuge; for in these homunculi we can neither suppose the moral nor rational constitution unfolded. Since, therefore, their degeneracy was not spontaneous, neither could their sufferings be equitable. Should it be said that the evil of original sin was penal, as it extended to our first parents alone, and merely consequential as felt by their posterity, it will be admitted that the distinction between penal and consequential evil may be intelligible in human affairs, where other laws, assortments, and combinations than those which are simply and purely moral, take place. But that a moral government, at one of the most cardinal periods of its administration, should admit gratuitous or consequential evil, seems to us irreconcilable with the attributes and conduct of a wise and just legislator. Consequential evil, taken as such, is misery sustained without demerit; and cannot result from the procedure of wisdom, benignity, and justice; but must flow from necessity, from ignorance, from cruelty, or from caprice, as its only possible sources. But even upon the supposition of those who pretend that

Pre-existence.

Pre-existence taught by Christian Platonists,

* See Pre-adamites. But no solution of original sin.

1
The Peripatetics maintained the eternity of the world.

2
Pre-existence of the soul taught by Asiatic sages.

3
Socratic arguments for pre-existence refuted.

Pre-existence || **Prefect.**
 that man was mature in all his faculties before the commission of original sin, the objections against it will still remain in full force: for it is admitted by all except the Samian sage, that the consciousness of personal identity which was felt in pre-existence, is obliterated in a subsequent state of being.

Now it may be demanded, whether agents thus refuscitated for punishment have not the same right to murmur and complain as if they had been perfectly innocent, and only created for that dreadful catastrophe? It is upon this principle alone that the effects of punishment can be either exemplary or disciplinary; for how is it possible, that the punishment of beings unconscious of a crime should ever be reconciled either to the justice or beneficence of that intention with which their sufferings are inflicted? Or how can others be supposed to become wise and virtuous by the example of those who are neither acquainted with the origin nor the tendency of their miseries, but have every reason to think themselves afflicted merely for the sake of afflicting? To us it seems clear, that the nature and *rationale* of original sin lie inscrutably retired in the bosom of Providence; nor can we, without unpardonable presumption and arrogance, form the most simple conclusion, or attempt the minutest discovery, either different from or extraneous to the clear and obvious sense of revelation. This sense indeed may with propriety be extracted from the whole, or from one passage collated with another; but independent of it, as reason has no premisses, she can form no deductions. The boldness and temerity of philosophy, not satisfied with contemplating pre-existence as merely relative to human nature, has dared to try how far it was compatible with the glorious Persons of the sacred Trinity. The Arians, who allowed the subordinate divinity of our Saviour, believed him pre-existent to all time, and before all worlds; but the Socinians, who esteemed his nature as well as his person merely human, insisted, that before his incarnation he was only pre-existent in the divine idea, not in nature or person. But when it is considered, that children do not begin to deduce instructions from nature and experience, at a period so late as we are apt to imagine; when it is admitted, that their progress, though insensible, may be much more rapid than we apprehend; when the opportunities of sense, the ardour of curiosity, the avidity of memory, and the activity of understanding, are remarked—we need not have recourse to a pre-existent state for our account of the knowledge which young minds discover. It may likewise be added, that moral agents can only be improved and cultivated by moral discipline. Such effects therefore of any state, whether happy or miserable, as are merely mechanical, may be noxious or salutary to the patient, but can never enter into any moral economy as parts of its own administration. Pre-existence, therefore, whether rewarded or punished, without the continued impression of personal identity, affords no solution of original sin.

PREFACE, something introductory to a book, to inform the reader of the design, method, &c. observed therein, and generally whatever is necessary to the understanding of a book.

PREFECT, in ancient Rome, one of the chief magistrates who governed in the absence of the kings, consuls, and emperors.

This power was greatest under the emperors. His chief care was the government of the city, taking cognizance of all crimes committed therein and within 100 miles. He judged capitally and finally, and even presided in the senate. He had the superintendence of the provisions, building, and navigation.

Prefect || **Prehnite.**
 The prefect of modern Rome differs little from the ancient *præfatus*, his authority only extending to 40 miles round the city.

PREFECT of the *Prætorium*, the leader of the pretorian bands destined for the emperor's guards, consisting, according to Dion, of 10,000 men. This officer, according to Suetonius, was instituted by Augustus, and usually taken from among the knights.

By the favour of the emperors his power grew very considerable; to reduce which, Constantine divided the prefecture of the *prætorium* into four prefectures, and each of these again he subdivided into civil and military departments, though the name was only reserved to him who was invested with the civil authority, and that of *comes belli* given him who commanded the cohorts.

PREGADI, in history, a denomination given to the senate of Venice, in which resides the whole authority of the republic. At its first institution it was composed of 60 senators, to whom 60 more have been added. See **VENICE**.

PREGNANCY, the state of a woman who has conceived, or is with child. See **MIDWIFERY**.

PREHNITE, a stone so named by Mr Werner, inspector of the mines of Freyburg, brought by Colonel Prehn from the Cape of Good Hope. In the first volume of *Chemical Annals* there is a chemical analysis of this stone extracted from the *Acta Naturæ Curiosorum*, Berlin, tom. viii. p. 211. an. 1788, part 2. by Klaproth; from which it appears, that 100 parts of prehnite contain silice

Alumine	-	-	-	43 $\frac{1}{2}$ grains.
Lime	-	-	-	30 $\frac{1}{2}$
Oxyd of iron	-	-	-	18 $\frac{1}{2}$
Water and air	-	-	-	5 $\frac{1}{2}$
				1 $\frac{1}{2}$
Total				100

Colonel Prehn gave it the name of emerald, and Mr Bruckmann adopted that denomination, but changed his opinion on considering that it had neither the hardness, the bright green colour, nor the property of crystallizing in hexagonal prisms like the emerald. The Dutch dealers call it *chrysoprasus* of the Cape; but chrysoprasus is nothing but quartz tinged green by the oxyd of nickel. Professor Haquet, in the 4th volume of the Berlin Transactions, has named it *crystallized prasus*. In the 8th volume, however, Mr Bruckmann considers it as a crystallized felt-spar. Mr Sage calls it *chrysolite*. Mr Rone de l'Isle classes it among the schoerls. To this classification Mr Klaproth objects, and is rather disposed with Mr Werner to consider it as a zeolite; on the whole, he thinks it may be conveniently ranked between zeolite and schoerl. Mr Hassenfratz published in the *Journal de Physique* for February 1788 an analysis of the same stone, under the title of *Pierre Silice, calcaire, alumineuse, &c. &c. de couleur verte, &c.* And according to his results, which are somewhat different from those of Mr Klaproth, and obtained by a different process, it contains, silice 50, lime 23.4, alumine 20.4, oxyd of iron 4.9, water 0.9, magnesia 0.5 = 100. The specific gravity of this stone, according to the experiments of Mr Brissón, is 2.9423. The dissection of its crystals, made by Abbé Haüy and Mr Hassenfratz, discovered

Prejudice. one angle of 60 degrees, as in schoerls; but it has hitherto been impossible to determine the others. The Abbé Hally has convinced himself, that it bears no resemblance to zeolite in its crystals. This stone scratches glass, and is itself scratched by rock crystal.

1
Definition. PREJUDICÉ, or PREJUDGMENT, from *præ* and *judicium*, means a judgment formed beforehand, without examination; the preposition *præ* expressing an anticipation, not so much of time as of knowledge and due attention: hence the schoolmen have called it *anticipation* and a *preconceived opinion*.

2
Origin of prejudice. Prejudice arises from the associating principle, which we have explained at large in another article (see METAPHYSICS, Part I. chap. 5.), and it is a weakness from which no human mind can be wholly free. Some are indeed much more than others under its influence; but there is no man who does not occasionally act upon principles, the propriety of which he never investigated; or who does not hold speculative opinions, into the truth of which he never seriously inquired. Our parents and tutors, yea our very nurses, determine a multitude of our sentiments: our friends, our neighbours, the custom of the country where we dwell, and the established opinions of mankind, form our belief; the great, the pious, the learned, and the ancient, the king, the priest, and the philosopher, are characters of mighty efficacy to persuade us to regulate our conduct by their practice, and to receive as truth whatever they may dictate.

The case cannot indeed be otherwise. The occasions of acting are so frequent, and the principles of action are so various, that were a man to investigate accurately the value of every single motive which presents itself to his mind, and to balance them fairly against each other, the time of acting would in most instances pass away long before he could determine what ought to be done; and life would be wasted in useless speculation. The great laws of religion and morality, which ought to be the general and leading principles of action, no man of science will take upon trust; but in the course of a busy life a thousand circumstances will occur in which we must act with such rapidity, that, after being satisfied of the lawfulness of what we are about to do, we must, for the prudence of it, confide entirely in the general customs of our country, or in the practice of other individuals placed in circumstances similar to ours. In all such cases, though we may act properly, we act from *prejudice*.

3
Its extensive dominion. But the dominion of prejudice is not confined to the actions of the man of business: it extends over the speculations of the philosopher himself, one half of whose knowledge rests upon no other foundation. All human sciences are related to each other (see PHILOSOPHY, n° 2.), and there is hardly one of them in which a man can become eminent unless he has some general acquaintance with the whole circle; but no man could ever yet investigate for himself all those propositions which constitute the circle of the sciences, or even comprehend the evidence upon which they rest, though he admits them perhaps as truths incontrovertible. He must therefore receive many of them upon the authority of others, or, which is the same thing, admit them by *prejudice*.

To this reasoning it may be objected, that when a man admits as true abstract propositions, which, though

not self-evident, he cannot demonstrate, he admits them not by prejudice, but upon testimony, which has been elsewhere shown to be a sufficient foundation for human belief (see METAPHYSICS, n° 138.) The objection is plausible, but it is not solid; for testimony commands belief only concerning events which, falling under the cognizance of the senses, preclude all possibility of mistake; whereas abstract propositions, not self-evident, can be proved true only by a *process of reasoning* or by a *series of experiments*; and in conducting both these, the most vigorous mind is liable to mistake. When Sir Isaac Newton told the world that it was the fall of an apple which first suggested to him the general law of gravitation, he bore testimony to a fact concerning which he could not be mistaken; and we receive his testimony for the reasons assigned in the article referred to. When he lays down the method of obtaining the fluxion or momentum of the rectangle or product of two indeterminate quantities, which is the main point in his doctrine of fluxions, he labours to establish that method on the basis of demonstration; and whoever makes use of it in practice, without understanding that demonstration, receives the whole doctrine of the modern geometrical analysis, not as a matter of *fact* upon the credit of Sir Isaac's testimony, but as a system of abstract truth on the credit of his *understanding*: in other words, he is a fluxionist by *prejudice*.

In vain will it be said, that in mathematical demonstration there is no room for mistake; and that therefore the man who implicitly adopts the method of fluxions may be considered as relying upon the *veracity* of its author, who had no inducement to deceive him, and whose comprehension was confessedly greater than his. In fluxionary mathematics, which treat of matters of which it is extremely difficult, if not impossible, to have adequate and steady conceptions, the most comprehensive mind is liable to mistake: and it is well known that the celebrated bishop of Cloyne wrote his *Analyst* to prove that the incomparable author of the method of fluxions had committed *two mistakes* in his fundamental proposition, which balancing one another, produced a true conclusion by false reasoning. One or other of these great men, of whom the least was an eminent mathematician, must have been bewildered in his reasoning, and have fallen into error; and therefore whoever follows either of them implicitly without perceiving the error of the other, is unquestionably under the influence of prejudice. This is the case with the writer of the present article. He perceives not the error of Bishop Berkeley's reasoning, and yet he admits the doctrine of fluxions on the authority of Sir Isaac's demonstration. That demonstration, however, he pretends not to understand; and therefore he admits the doctrine through *prejudice*.

4
We have made these observations to point out the impossibility of the fashionable cry against the harbouring to eradicate all prejudices from the human mind is impossible; and if it were possible, it would be very unwise: for we see that prejudice may exist on the side of truth as well as on that of falsehood; and that principles professed and believed by any individual may be useful and true, though he was brought to them not by a train of fair and candid reasoning, but through the medium of prepossession or authority. Indeed such is our nature, and such are the laws of association,

Prejudice. sociation, that many of our best principles, and our obligation to perform many of the most amiable of our duties in common life, must evidently be acquired in this way: From endearing associations, and authoritative instruction, we acquire a knowledge of our duty to our parents, and a facility in performing it, together with the first principles of religion, without a single effort of our own reason. Even when reason has begun to assert its power, and shows us the propriety of such duties, we are wonderfully assisted in performing them by the amiable prejudices which we had before acquired, and which now appear to be natural to us. He who has never had the advantage of such associations, and who acquires a knowledge of the duties suggested by them after he has come to years of discretion, and chiefly by the efforts of his own reason, will seldom, *ceteris paribus*, perform those duties with an energy and delight equal to that of the person who has. This remark appears to be confirmed by experience; for it is often found, that the children of the great, who have been given out to nurse in their infancy, and who have seldom been in the company of their parents till their reasoning faculties have been far advanced, are much less dutiful and affectionate than those in the middle or lower stations of life, who have scarcely ever been out of their parents company.

5
Which would not be wise if it were possible.

Would it then be wise, even if it were practicable, to dissolve all those associations which tend so powerfully to increase the mutual affections of parents and children? We cannot think that it would; as we believe it might be easily shown that public spirit springs out of private affection. Plato indeed held an opinion very different from ours; for in order to extend that affection which is usually lavished at home to the whole state, he proposed that children should be educated at the public expence, and never be permitted to know the authors of their being. But this is only one of the many visionary projects of that great man, of which daily experience shows the absurdity. In modern times, we are certain that less dependence is to be had upon the *patriotism* of the man who, for the love which he pretends to his country, can overlook or forget his own partial connections in it, than on him who, at the same time that he wishes his country well, is feelingly alive to all the endearments of kindred affection.

Such affection may be called *partial*, and very probably has its foundation in that which is the source of all our prejudices: but if it be properly trained in early life, it will gradually extend from our nearest relations to the persons with whom we associate, and to the place which not only gave us birth, but also furnished our youthful and most innocent enjoyments. It is thus that the *amor patriæ* is generated (see *PASSION* and *PATRIOTISM*), which in minds unseduced by false principles is exceedingly strong; and though a partial affection, is of the most general utility. It is this prejudice which reconciles the Laplander to his freezing snows, and the African to his burning sun; which attaches the native of the Highlands or of Wales as much to his mountains and rocks, as the apparently happier inhabitant of the southern counties of England is to the more fertile and delightful spot where he drew his first breath. And we find in fact, that when a native of Kent and a Scotch Highlander have in some distant corner of the world gained a competent fortune without

6
Good effects of some prejudices.

being corrupted by luxury, they return, the one to his hop-gardens, and the other to his mountains. Were this prejudice, for such it surely is, wholly eradicated from the human mind, it is obvious that large tracts of country which are now full of inhabitants would be totally deserted; and that the hungry barbarians, to make room for themselves, would exterminate the proprietors of more favourable climes. From an affection to our friends and to our country, we naturally contract an affection for that mode of government under which we live; and unless it be particularly oppressive to ourselves or any order of citizens, we come as naturally to prefer it to all other modes, whether it deserve that preference or not. This no doubt is prejudice, but it is a beneficial prejudice; for were the multitude, who are wholly incapable of estimating the excellencies and defects of the various modes of government, to become dissatisfied with their own, and rise in a mass to change it for the better, the most horrible consequences might justly be dreaded. Of this truth the present state of Europe affords too melancholy and convincing a proof. The man therefore who, under the pretence of enlightening the public mind and extirpating prejudices, paints to the illiterate vulgar, in aggravated colours, the abuse of that government which has hitherto protected them from the ferocity of each other, is one of the greatest criminals if his views be selfish, and one of the worst reasoners if they be disinterested, that human imagination can easily conceive.

With the selfish patriot we have at present no concern; but we may with propriety ask the disinterested lover of truth, whether he thinks it possible, that in a large community, of which nine-tenths of the members are necessarily incapable of taking comprehensive views of things, or feeling the force of political reasonings, any form of government can be acceptable to the people at large, which does not gain their affections through the medium of prejudice? It has been shown by Mr Hume with great strength of argument, that government is founded on *opinion*, which is of two kinds, viz. opinion of interest, and opinion of right. By opinion of interest, he understands the sense of the general advantage which is reaped from government, together with the persuasion that the particular government which is established is equally advantageous with any other that could easily be settled. The opinion entertained of the *right* of any government is always founded in its antiquity; and hence arises the passionate regard which under ancient monarchies the people have for the true heir of their royal family. These opinions, as held by the philosopher conversant with the history of nations, are founded upon reasoning more or less conclusive; but it is obvious, that in the minds of the multitude they can have no other foundation than prejudice. An illiterate clown or mechanic does not *see how* one form of government promotes the general interest more than another; but he may *believe* that it does, upon no other evidence than the declamation of a demagogue, who, for selfish purposes, contrives to flatter his pride. The same is the case with respect to the rights of hereditary monarchy. The anatomist finds nothing more in the greatest monarch than in the meanest peasant, and the moralist may perhaps frequently find less; but the true philosopher acknowledges his right to the sovereignty: and though he be weak in understanding, or infirm in years, would, for

7
Danger of improper attempts to remove them.

Prejudice. the sake of public peace and the stability of government, maintain him in his throne against every competitor of the most shining talents. The vulgar, however, who would act with this philosopher, are influenced by no such views, but merely by their prejudices in favour of birth and family; and therefore it is ridiculous to think of changing the public mind with respect to any form of government by pure reasoning. In France a total change in the minds of the people has indeed been effected, and from the most violent prejudices in favour of royalty, they have now become more violently prejudiced in favour of republicanism. Bad as their government unquestionably was, the change that has now taken place is not the effect of calm reasoning and accurate inquiry (for of that the bulk of mankind appears to be incapable), nor are their prejudices less violent than they were before. They are changed indeed; but no one will deny that prejudice, and that of the most violent kind, leads them on at present; nor can any one assert that their new prejudices have rendered them more happy, or their country more flourishing, than their former ones, which made them cry *Vive le Roi* under the tyrannic government of Louis XIV.

The influence of prejudice is not more powerful in fixing the political opinions of men, than in dictating their religious creed. Every child of a religious father receives his faith by inheritance long before he be capable of judging whether it be agreeable or disagreeable to the word of God and the light of reason. This experience shows to be the fact; and sound philosophy declares that it cannot be otherwise. Parents are appointed to judge for their children in their younger years, and to instruct them in what they should believe, and what they should practise in the civil and religious life. This is a dictate of nature, and doubtless would have been so in a state of perfect innocence. It is impossible that children should be capable of judging for themselves before their minds are furnished with a competent number of ideas, and before they are acquainted with any *principles* and *rules* of just reasoning; and therefore they can do nothing better than run to their parents, and receive their directions what they should believe and what they should practise.

This mode of tutoring the infant mind, and giving to our instructions the force of prejudice, before reason can operate with much effect, will, we know, be highly displeasing to many who challenge to themselves alone the epithet of liberal. With them it will be cramping the genius and perverting the judgment: but we cannot help thinking that such an objection, if it should be made, would be the offspring of ignorance; for it requires but very little knowledge of human nature to be able to see, that if children be not restrained by authority, and if we do not insinuate a love of good principles into their minds, bad ones will insinuate themselves, and a little time will give them the force of inveterate prejudice, which all the future efforts of reason and philosophy will find it difficult to eradicate. The idea of keeping a child ignorant of the being of a God, and the grand duties of morality and religion, till he shall come to years of discretion, and then allowing him to reason them out for himself, is an absurd chimera: it is an experiment which never has been tried, which to us it appears impossible to try, and which, if it could be tried, could not possibly produce any good effect. For sup-

pose we had a youth just arrived at years of discretion, totally ignorant of all these things, and unbiassed to any system of opinions, or rather possessed of no opinions at all—it would, in the first place, we suspect, be absolutely necessary to direct his thoughts into a particular train, and for some person to lead him on from one idea to another, till he should arrive at some conclusion: but in all this there is the influence of authority, association, and of prejudice.

It being therefore absolutely necessary that sentiments of religion be instilled into the minds of children before they be capable of discovering by the use of their reason whether those sentiments be just or not, it need not excite wonder, nor is it any reflection upon religion, that most men adhere with bigotry to the creed of their fathers, and support that creed by arguments which could carry conviction to no minds but their own. The love and veneration which they bear to the memory of those from whom they imbibed their earliest opinions, do not permit them to perceive either the falsehood of those opinions, or their little importance, supposing them true. Hence the many frivolous disputes which have been carried on among Christians; and hence the zeal with which some of them maintain tenets which are at once contrary to scripture, to reason, and to common sense. A due reflection, however, on the source of all prejudices ought to moderate this zeal; for no man is wholly free from that bias which he is so ready to condemn in others: and indeed a man *totally free from prejudice*, would be a more unhappy being than the most violent bigot on earth. In science, he would admit nothing which he could not himself demonstrate; in business, he would be perpetually at a stand for want of motives to influence his conduct: he could have no attachment to a particular country; and therefore must be without patriotism, and without the solaces of friendship; and his religion, we are afraid, would be cold and lifeless.

What, it will be said, are the authors of a work which professes to enlighten the public mind by laying before it a general view of science and literature, become at last the advocates of *prejudice*, which is the *bane* of science, and the *prop* of *superstition*? No, we are advocates for no prejudice which is either inimical to science or friendly to absurdity; but we do not think that the moralist would act wisely who should desert his proper business to make himself master of the higher mathematics, merely that he might not be obliged to trust occasionally to the demonstrations of others. The writer of this article is not skilled in trade; but it is not his opinion that the merchant would soon grow rich, who should never make a bargain till he had previously calculated with mathematical exactness all the probabilities of his gain or loss. That to dissolve all the associations which are the source of partial attachments of kindred, affection, and private friendship, would tend to promote the public happiness, we cannot possibly believe. And we think, that the experience of the present eventful day abundantly confirms Mr Hume's opinion, that far from endeavouring to extirpate the people's prejudices in favour of birth and family, we should cherish such sentiments, as being absolutely requisite to preserve a due subordination in society. That men would be better Christians if they were to receive no religious instruction till they should be able by their own reason to judge of

8
Absurdity of keeping children ignorant of religion from the dread of prejudice.

10
An objection answered.

Prejudice. Its truth, daily observation does not warrant us to conclude; for we see those who have seldom heard of God when children, "live without him in the world" when they are men.

Pernicious prejudices we have traced to their source elsewhere, and shown how they may be best prevented by proper attention in the education of children. (See *METAPHYSICS*, n^o 98). We shall only add here, that the earlier such attention is paid, the more effectual it will be found; and that it is much easier to keep prejudices out of the mind than to remove them after they have been admitted. This however must be sometimes attempted; and where prejudices are strong, several methods have been recommended for rendering the attempt successful. The following are taken mostly from Dr Watts's improvement of the mind.

11
Proper methods of removing prejudices.

1. Never attack the prejudice *directly*, but lead the person who is under its influence step by step to the truth. Perhaps your neighbour is under the influence of *superstition and bigotry in the simplicity of his soul*; you must not immediately run upon him with violence, and show him the absurdity or folly of his own opinions, though you might be able to set them in a glaring light; but you must rather begin at a distance, and establish his assent to some familiar and easy propositions, which have a tendency to refute his mistakes, and to confirm the truth; and then silently observe what impression this makes upon him, and proceed by slow degrees as he is able to bear, and you must carry on the work perhaps at distant seasons of conversation. The tender or diseased eye cannot bear a deluge of light at once.

Overhastiness and vehemence in arguing is oftentimes the effect of *pride*; it blunts the poignancy of the argument, breaks its force, and disappoints the end. If you were to convince a person of the falsehood of the doctrine of *transubstantiation*, and you take up the consecrated bread before him and say, "You may see, and taste, and feel, *this is nothing but bread*; therefore whilst you assert that God commands you to believe *it is not bread*, you most wickedly accuse God of commanding you to tell a lie." This sort of language would only raise the indignation of the person against you, instead of making any impressions upon him. He will not so much as think at all on the argument you have brought, but he rages at you as a *profane wretch*, setting up your own sense and reason above sacred authority; so that though what you affirm is a truth of great evidence, yet you lose the benefit of your whole argument by an ill management, and the unreasonable use of it.

2. Where the prejudices of mankind cannot be conquered at once, but will rise up in arms against the evidence of truth, there we must make some allowances, and yield to them for the present, as far as we can safely do it without real injury to truth; and if we would have any success in our endeavours to convince the world, we must practise this complaisance for the benefit of mankind. Take a student who has deeply imbibed the principles of the *Peripatetics*, and imagines certain immaterial beings, called *substantial forms*, to inhabit every herb, flower, mineral, metal, fire, water, &c. and to be the spring of all its properties and operations; or take a Platonist, who believes an *anima mundi*, "an universal soul of the world," to pervade all bodies, to act in and by them according to their nature,

and indeed to give them their nature and their special powers; perhaps it may be very hard to convince these persons by arguments, and constrain them to yield up those fancies. Well then, let the one believe his *universal soul*, and the other go on with his notion of *substantial forms*, and at the same time teach them how by certain original laws of motion, and the various sizes, shapes, and situations of the parts of matter, allowing a continued divine concurrence in and with all, the several appearances in nature may be solved, and the variety of effects produced, according to the corpuscular philosophy, improved by *Descartes*, *Mr Boyle*, and *Sir Isaac Newton*; and when they have attained a degree of skill in this science, they will see these airy notions of theirs, these imaginary powers, to be so useless and unnecessary, that they will drop them of their own accord. The *Peripatetic forms* will vanish from the mind like a dream, and the *Platonic soul of the world* will expire.

We may give another instance of the same practice, where there is a prejudicate fondness of particular words and phrases. Suppose a man is educated in an *unhappy form of speech*, whereby he explains some *great doctrine of the gospel*, and by the means of this phrase he has imbibed a very false idea of that doctrine; yet he is so bigotted to his form of words, that he imagines if those words are omitted the form is lost. Now, if we cannot possibly persuade him to part with his improper terms, we will indulge them a little, and try to explain them in a scriptural sense, rather than let him go on in his mistaken ideas. A person who has been bred a *Papist*, knows but little of religion, yet he resolves never to part from the *Roman Catholic faith*, and is obstinately bent against a change. Now it cannot be unlawful to teach such an one the true Christian, *i. e.* the *Protestant religion*, out of the *Epistle to the Romans*, and show him that the same doctrine is contained in the *Catholic Epistles of St Peter, James, and Jude*; and thus let him live and die a good Christian in the belief of the religion taught him out of the New Testament, while he imagines he is a *Roman Catholic* still, because he finds the doctrine he is taught in the *Catholic Epistles* and in that to the *Romans*. Sometimes we may make use of the very prejudices under which a person labours, in order to convince him of some particular truth, and argue with him upon his own professed principles as though they were true. Suppose a *Jew* lies sick of a fever, and is forbid flesh by his physician; but hearing that rabbits were provided for the dinner of the family, desired earnestly to eat of them; and suppose he became impatient, because his physician did not permit him, and he insisted upon it that it could do him no hurt—surely rather than let him persist in that fancy and that desire, to the danger of his life, we might tell him that these animals were strangled, a sort of food forbidden by the Jewish law, though we ourselves might believe that law to be abolished.

Where we find any person obstinately persisting in a mistake in opposition to all reason, especially if the mistake be very injurious or pernicious, and we know this person will hearken to the sentiment or authority of some favourite name; it is needful sometimes to urge the *opinion and authority* of that favourite person, since that is likely to be regarded much more than *reason*. We are almost ashamed indeed to speak of using any *influence of authority* in reasoning or argument; but in some cases

Prejudice cases it is better that poor, silly, perverse, obstinate creatures, should be persuaded to judge and act right, by a veneration for the sense of others, than to be left to wander in pernicious errors, and continue deaf to all argument, and blind to all evidence. They are but children of a larger size; and since they persist all their lives in their minority, and reject all true reasoning, surely we may try to persuade them to practise what is for their own interest by such childish reasons as they will hearken to. We may overawe them from pursuing their own ruin by the terrors of a solemn shadow, or allure them by a sugar plum to their own happiness. But after all, we must conclude, that wheresoever it can be done, it is best to *remove and root out those prejudices* which obstruct the entrance of truth into the mind, rather than to palliate, humour, or indulge them; and sometimes this must necessarily be done, before you can make a person part with some beloved error, and lead him into better sentiments.

12 Mutual forbearance recommended. On the whole, we would recommend more mutual forbearance and less acrimony than is commonly found among writers on disputed subjects, as the only means by which our differences in religion, politics, and science, ever can be healed, and truth certainly discovered. If men were less violent in defending their particular opinions, they would always gain a more patient hearing, they would be less suspected of, and less liable to, prejudice, and of course more apt either to convince or to be convinced. They would likewise by so doing show, in the most unequivocal manner, their attention to found philosophy, and above all to genuine Christianity; which, though it is far from encouraging scepticism, or a temporizing spirit, recommends, in the strongest terms, among all its professors, *universal charity and mutual forbearance*. See **PROBABILITY, TRUTH, and SUPERSTITION**.

PRELATE, an ecclesiastic raised to some eminent and superior dignity in the church; as bishops, archbishops, patriarchs, &c.

PRELIMINARY, in general, denotes something to be examined and determined before an affair can be treated of to the purpose.

PRELUDE, in music, is usually a flourish or irregular air, which a musician plays off-hand, to try if his instrument be in tune, and so lead him into the piece to be played.

PREMISSES, in logic, an appellation given to the two first propositions of a syllogism. See **LOGIC**.

PREMISSES, in law, properly signifies the land, &c. mentioned in the beginning of a deed.

PREMIUM, or **PRÆMIUM**, properly signifies a reward or recompense: but it is chiefly used in a mercantile sense for the sum of money given to an insurer, whether of ships, houses, lives, &c. See **INSURANCE**.

PREMNA, in botany; a genus of the angiosperma order, belonging to the didynamia class of plants. The calyx is bilobed; the corolla quadrifid; the berry quadrilocular; the seeds solitary.

PREMONSTRANTES, or **PRÆMONSTRATENSES**, a religious order of regular canons instituted in 1120, by S. Norbert; and thence also called *Norbertines*.

The first monastery of this order was built by Norbert in the Isle of France, three leagues to the west of Laon; which he called *Præmonstre, Præmonstratum*, and

hence the order itself derived its name; though as to the occasion of that name, the writers of that order are divided. At first the religious of this order were so very poor, that they had only a single ass, which served to carry the wood they cut down every morning, and sent to Laon in order to purchase bread. But they soon received so many donations, and built so many monasteries, that in 30 years after the foundation of the order, they had above 100 abbeys in France and Germany: and in process of time the order so increased, that it had monasteries in all parts of Christendom, amounting to 1000 abbeys, 300 provostships, a vast number of priories, and 500 nunneries. But they are now greatly diminished. The rule they followed was that of St Augustine, with some slight alterations, and an addition of certain severe laws, whose authority did not long survive their founder.

The order was approved by Honorius II. in 1126, and again by several succeeding popes. At first the abstinence from flesh was rigidly observed. In 1245 Innocent IV. complained of its being neglected to a general chapter. In 1288, their general, William, procured leave of pope Nicholas IV. for those of the order to eat flesh on journeys. In 1467, Pius II. granted them a general permission to eat meat, excepting from Septuagesima to Easter. The dress of the religious of this order is white, with a scapulary before the cassock. Out of doors they wear a white cloak and white hat; within, a little camail; and at church, a surplice, &c.

In the first monasteries built by Norbert, there was one for men and another for women, only separated by a wall. In 1137, by a decree of a general chapter, this practice was prohibited, and the women removed out of those already built, to a greater distance from those of the men.

The *Præmonstratenses*, or monks of Premontre, vulgarly called *white canons*, came first into England, A. D. 1146. Their first monastery, called *New-house*, was erected in Lincolnshire, by Peter de Saulia, and dedicated to St Martial. In the reign of Edward I. this order had 27 monasteries in England.

PRENANTHES, in botany: A genus of the polygamia æqualis order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, *Compositæ*. The receptacle is naked; the calyx calyculated; the pappus is simple, and almost sessile; the florets are placed in a single series.

PRENOMEN, **PRÆNOMEN**, among the ancient Romans, a name prefixed to their family name, and answering to our Christian name: such are Caius, Lucius, Marcus, &c.

PRENOTION, **PRÆNOTIO**, or *Præcognitio*, is a notice or piece of knowledge preceding some other in respect of time. Such is the knowledge of the antecedent, which must precede that of the conclusion. It is used by Lord Bacon for breaking of an endless search, which he observes to be one of the principal parts of the art of memory. For when one endeavours to call any thing to mind, without some previous notion or perception of what is sought for, the mind exerts itself and strives in an endless manner: but if it hath any short notion before-hand, the infinity of the search is presently cut off, and the mind hunts nearer home, as in an inclosure. Thus verse is easier remembered than prose; because if we stick at any word in a verse, we have

Præmonstrantes
||
Prenotion.

Prepara-
tion.

have a previous notion that it is such a word as must stand in a verse. Hence also, order is a manifest help to memory; for here is a previous notion, that the thing sought for must be agreeable to order. Bacon's *Works Abr.* vol. i. p. 136. and vol. ii. p. 473.

PREPARATION, in a general sense, the act of disposing things in such a manner as to render any foreseen event more advantageous or less hurtful according to its nature.

PREPARATION of *Dissonances*, in music, is their disposition in harmony in such a manner, that, by something congenial in what precedes, they may be rendered less harsh to the ear than they would be without that precaution: according to this definition, every discord ought to be prepared. But when, in order to prepare a dissonance, it is exacted that the sound which forms it should before have formed a consonance, then there is fundamentally but one single dissonance which is prepared, viz. the seventh. Nor is even this preparation necessary in the chord which contains the sensible note, because then the dissonance being characteristic, both in its chord and in its mode, the ear has sufficient reason to expect it: it accordingly does expect it, and recognise it; nor is either deceived with respect to its chord nor its natural progress. But when the seventh is heard upon a fundamental sound which is not essential to the mode, it ought then to be prepared, in order to prevent all ambiguity; to prevent the ear, whilst listening to this note, from losing its train: and as this chord of the seventh may be inverted and combined in several different manners, from this arise likewise a number of different ways by which it may seem to be prepared, which, in the main, always issue however in the same thing.

In making use of dissonances, three things are to be considered; viz. the chord which precedes the dissonance, that in which it is found, and that which is immediately subsequent to it. Preparation only respects the two first; for the third, see RESOLUTION.

When we would regularly prepare a discord in order to arrive at its chord, we must choose such a career of the fundamental bass, that the sound which forms the dissonance may be a protraction into the perfect time of the same note which formed a consonance formerly struck in the imperfect in the preceding chord; this is what we call *sincopation*. See SINCOPATION.

From this preparation two advantages result; viz. 1. That there is necessarily an harmonical connection between the two chords, since that connection is formed by the dissonance itself; and, 2. That this dissonance, as it is nothing else but the continuation of the same sound which had formed a consonance, becomes much less harsh to the ear than it would have been with any sound recently struck. Now this is all that we expect to gain by preparation. See CADENCE, DISCORD, and HARMONY.

By what has been just said, it will appear that there is no other part peculiarly destined for preparing the dissonance, except that in which it is heard; so that if the treble shall exhibit a dissonance, that must be sincopated; but if the dissonance is in the bass, the bass must be sincopated. Though there is nothing here but what is quite simple, yet have masters of music miserably embroiled the whole matter.

Some dissonances may be found which are never prepared: such is the sixth superadded: some which are very unfrequently prepared; such is the diminished seventh.

PREPARATIONS, in pharmacy, the medicines when mixed together in such a manner as to be fit for the use of the patient. See PHARMACY, Part II.

PREPARATIONS, in anatomy, the parts of animal bodies prepared and preserved for anatomical uses.

The manner of preserving anatomical preparations, is either by drying them thoroughly in the air, or putting them into a proper liquor.

In drying parts which are thick, when the weather is warm, care must be taken to prevent putrefaction, fly-blows, insects, &c. This is easily done by the use of a solution of corrosive sublimate in spirit of wine, in the proportion of two drams of sublimate to a pound of spirit: the part should be moistened with this liquor as it dries, and by this method the body of a child may be kept safe even in summer. Dried preparations are apt to crack and moulder away in keeping; to prevent this, their surface should be covered with a thick varnish, repeated as often as occasion requires.

Though several parts prepared dry are useful, yet others must be so managed as to be always flexible, and nearer a natural state. The difficulty has been to find a proper liquor for this purpose. Dr Monro says, the best he knows is a well rectified colourless spirit of wine, to which is added a small quantity of the spirit of vitriol or nitre. When these are properly mixed, they neither change their colour nor the consistence of the parts, except where there are serous or mucous liquors contained in them. The brain, even of a young child, in this mixture grows so firm as to admit of gentle handling, as do also the vitreous and crystalline humours of the eye. The liquor of the sebaceous glands and the semen are coagulated by this spirituous mixture; and it heightens the red colour of the injection of the blood-vessels, so that after the part has been in it a little time, several vessels appear which were before invisible. If you will compare these effects with what Ruysch has said of his balsam, you will find the liquor above-mentioned to come very near to it.

The proportion of the two spirits must be changed according to the part prepared. For the brain and humours of the eye, you must put two drams of spirit of nitre to one pound of spirit of wine. In preserving other parts which are harder, 30 or 40 drops of the acid will be sufficient; a larger quantity will make bones flexible, and even dissolve them. The part thus preserved should be always kept covered with the liquor: therefore great care should be taken to stop the mouth of the glass with a waxed cork and a bladder tied over it, to prevent the evaporation of the spirit; some of which, notwithstanding all this care, will fly off; therefore fresh must be added as there is occasion. When the spirits change to a dark tincture, which will sometimes happen, they should be poured off, and fresh put in their room; but with somewhat less acid than at first.

The glasses which contain the preparations should be of the finest sort, and pretty thick; for through such the parts may be seen very distinctly, and of a true colour, and the object will be so magnified as to show

Prepara-
tion.Edin. Med.
Essays,
vol. ii. p. 84

Prepared show vessels in the glass which out of it were not to be seen.

Prerogative.

As the glass when filled with the liquor has a certain focus, it is necessary to keep the preparation at a proper distance from the sides of it, which is easily done by little sticks suitably placed, or by suspending it by a thread in a proper situation. The operator should be cautious of putting his fingers in this liquor oftener than is absolutely necessary; because it brings on a numbness on the skin, which makes the fingers unfit for any nice operation. The best remedy for this is to wash them in water mixed with a few drops of oil of tartar per deliquium.

Dr Christ. Jac. Trew prefers the rectified spirit of grain for preserving anatomical preparations to spirit of wine, or to compositions of alcohol, amber, camphor, &c. because these soon change into a brown colour, whereas the spirit from malt preserves its limpid appearance. When any part is to be preserved wet, wash it with water till it is no more tintured. The water is next to be washed away with spirits, and then the preparation is to be put among spirits in a glass, the mouth of which is to be closely covered with a glass head, over which a wet bladder and leaf-tin are to be tied. *Com. Lit. Norimb. 1731, semest. 1. specim. 9.* See also *Pole's Anatomical Instructor*, and *American Transactions*, vol. ii. p. 366.

PREPENSED, in law, denotes fore-thought. In which sense we say *prepensd malice*, &c. If, when a man is slain upon a sudden quarrel, there were malice prepensed formerly between them, it makes it murder; and, as it is called in some statutes, *prepensd murder*.

PREPOSITION, in grammar, one of the parts of speech, being an indeclinable particle which yet serves to govern the nouns that follow it; such as *per*, *pro*, *propter*; and *through*, *for*, *with*, &c.

F. Buffier allows it to be only a modificative of a part of speech, serving to circumstantiate a noun.

PREPUCE, in anatomy, the foreskin, being a prolongation of the cutis of the penis, covering the glans. See ANATOMY, n° 107.

PREROGATIVE, an exclusive or peculiar privilege.

Royal PREROGATIVE, that special pre-eminence which the king hath over and above all other persons, and out of the ordinary course of the common law, in right of his regal dignity. It signifies in its etymology (from *præ* and *rogō*) something that is required or demanded before, or in preference to, all others. And hence it follows, that it must be in its nature singular and eccentric; that it can only be applied to those rights and capacities which the king enjoys alone in contradistinction to others, and not to those which he enjoys in common with any of his subjects: for if once any one prerogative of the crown could be held in common with the subject, it would cease to be prerogative any longer. And therefore Finch lays it down as a maxim, that the prerogative is that law in case of the king, which is law in no case of the subject.

Prerogatives are either *direct* or *incidental*. The *direct* are such positive substantial parts of the royal character and authority, as are rooted in, and spring from, the king's political person, considered merely by itself, without reference to any other extrinsic cir-

cumstance; as, the right of sending ambassadors, of creating peers, and of making war or peace. But such prerogatives as are *incidental* bear always a relation to something else, distinct from the king's person; and are indeed only exceptions, in favour of the crown, to those general rules that are established for the rest of the community: such as, that no costs shall be recovered against the king; that the king can never be a joint tenant; and that his debt shall be preferred before a debt to any of his subjects.

These substantive or direct prerogatives may again be divided into three kinds: being such as regard, first, the king's royal *character* or *dignity*; secondly, his royal *authority* or *power*; and, lastly, his royal *income*. These are necessary, to secure reverence to his person, obedience to his commands, and an affluent supply for the ordinary expences of government; without all of which it is impossible to maintain the executive power in due independence and vigour. Yet, in every branch of this large and extensive dominion, our free constitution has interposed such seasonable checks and restrictions, as may curb it from trampling on those liberties which it was meant to secure and establish. The enormous weight of prerogative, if left to itself, (as in arbitrary governments it is), spreads havock and destruction among all the inferior movements: but, when balanced and bridled (as with us) by its proper counterpoise, timely and judiciously applied, its operations are then equable and regular; it invigorates the whole machine, and enables every part to answer the end of its construction.

I. Of the royal *dignity*. Under every monarchical establishment, it is necessary to distinguish the prince from his subjects, not only by the outward pomp and decorations of majesty, but also by ascribing to him certain qualities as inherent in his royal capacity, distinct from, and superior to, those of any other individual in the nation. For though a philosophical mind will (says Sir William Blackstone) consider the royal person merely as one man appointed by mutual consent to preside over many others, and will pay him that reverence and duty which the principles of society demand; yet the mass of mankind will be apt to grow insolent and refractory, if taught to consider their prince as a man of no greater perfection than themselves. The law therefore ascribes to the king, in his high political character, not only large powers and emoluments, which form his prerogative and revenue, but likewise certain attributes of a great and transcendent nature; by which the people are led to consider him in the light of a superior being, and to pay him that awful respect which may enable him with greater ease to carry on the business of government. This is what we understand by the royal dignity; the several branches of which we shall now proceed to enumerate.

1. And, first, the law ascribes to the king the attribute of *sovereignty*, or pre-eminency. See SOVEREIGNTY.

2. "The law also (according to Sir William Blackstone) ascribes to the king, in his political capacity, absolute *perfection*. 'The king can do no wrong.' Which ancient and fundamental maxim (says he) is not to be understood as if every thing transacted by the government was of course just and lawful; but means only two things. First, that whatever

Prerogative.

Prerogative.

is exceptionable in the conduct of public affairs, is not to be imputed to the king, nor is he answerable for it personally to his people: for this doctrine would totally destroy that constitutional independence of the crown, which is necessary for the balance of power, in our free and active, and therefore compounded, constitution. And, secondly, it means that the prerogative of the crown extends not to do any injury; it is created for the benefit of the people, and therefore cannot be exerted to their prejudice.—“The king, moreover, (he observes), is not only incapable of *doing* wrong, but even of *thinking* wrong: he can never mean to do an improper thing: in him is no folly or weakness. And, therefore, if the crown should be induced to grant any franchise or privilege to a subject contrary to reason, or in anywise prejudicial to the commonwealth or a private person, the law will not suppose the king to have meant either an unwise or an injurious action, but declares that the king was deceived in his grant; and thereupon such grant is rendered void, merely upon the foundation of fraud and deception, either by or upon those agents whom the crown has thought proper to employ. For the law will not cast an imputation on that magistrate whom it entrusts with the executive power, as if he was capable of intentionally disregarding his trust: but attributes to mere imposition (to which the most perfect of sublunary beings must still continue liable) those little inadvertencies, which, if charged on the will of the prince, might lessen him in the eyes of his subjects.”

But this doctrine has been exposed as ridiculous and absurd, by Lord Abingdon, in his *Dedication to the collective Body of the People of England*. “Let us see (says he) how these maxims and their comments agree with the constitution, with nature, with reason, with common sense, with experience, with fact, with precedent, and with Sir William Blackstone himself; and whether, by the application of these rules of evidence thereto, it will not be found, that (from the want of attention to that important line of distinction which the constitution has drawn between the *king* of England and the *crown* of England) what was attributed to the *monarchy* has not been given to the *monarch*, what meant for the *kingship* conveyed to the *king*, what designed for the *thing* transferred to the *person*, what intended for *theory* applied to *practice*; and so in consequence, that whilst the premises (of the perfection of the monarchy) be true, the conclusion (that the king can do no wrong) be not false.

“And, first, in reference to the constitution: to which if this matter be applied (meaning what it expresses, and if it do not it is unworthy of notice), it is subversive of a principle in the constitution, upon which the preservation of the constitution depends; I mean the principle of *resistance*; a principle which, whilst no man will now venture to gainsay, Sir William Blackstone himself admits, ‘*is justifiable to the person of the prince*, when the being of the state is endangered, and the public voice proclaims such resistance necessary;’ and thus, by such admission, both disproves the maxim, and oversets his own comment thereupon: for to say that ‘the king can do no wrong,’ and that ‘he is incapable even of thinking wrong,’ and then to admit that ‘resistance to his person is justifiable,’ are such

Vol. XV. Part II.

jarring contradictions in themselves, that, until reconciled, the necessity of argument is suspended.

“With respect then, in the next place, to the agreement of this maxim, and its comment, with nature, with reason, and with common sense, I should have thought myself sufficiently justified in appealing to every man’s own reflection for decision, if I had not been made to understand that nature, reason, and common sense, had had nothing to do with either. Sir William Blackstone says, ‘That though a philosophical mind will consider the royal person merely as one man appointed by mutual consent to preside over others, and will pay him that reverence and duty which the principles of society demand, yet the mass of mankind will be apt to grow insolent and refractory if taught to consider their prince as a man of no greater perfection than themselves; and therefore the law ascribes to the king, in his high political character, certain attributes of a great and transcendent nature, by which the people are led to consider him in the light of a superior being, and to pay him that awful respect which may enable him with greater ease to carry on the business of government.’ So that, in order to govern with greater ease (which by the bye is mere assertion without any proof), it is necessary to deceive the mass of mankind, by making them believe, not only what a philosophical mind cannot believe, but what it is impossible for any mind to believe; and therefore, in the investigation of this subject, according to Sir William, neither nature, reason, nor common sense, can have any concern.—

“It remains to examine in how much this maxim and its comment agree with experience, with fact, with precedent, and with Sir William Blackstone himself. And here it is matter of most curious speculation, to observe a maxim laid down, and which is intended for a rule of government, not only without a single case in support of it, but with a string of cases, that may be carried back to Egbert the first monarch of England, in direct opposition to the doctrine. Who is the man, that, reading the past history of this country, will show us any king that has done no wrong? Who is the reader that will not find, that all the wrongs and injuries which the free constitution of this country has hitherto suffered, have been solely derived from the arbitrary measures of our kings? And yet the mass of mankind are to look upon the king as a superior being; and the maxim, that ‘the king can do no wrong,’ is to remain as an article of belief. But, without pushing this inquiry any farther, let us see what encouragement Sir William Blackstone himself has given us for our credulity. After stating the maxim, and presenting us with a most lively picture, ‘of our sovereign lord thus *all perfect* and *immortal*,’ what does he make this all-perfection and immortality in the end to come to? His words are these: ‘For when king Charles’s deluded brother attempted to *enslave* the nation,’ (*no wrong this, to be sure*), ‘he found it was beyond his power: the people both *could*, and *did*, resist him; and in consequence of such resistance, obliged him to quit his enterprise and his throne together *.”

The sum of all is this: That the crown of England and the king of England are distinguishable, and not synonymous terms: that allegiance is due to the crown, and through the crown to the king: that the attributes

Prerogative.

* Comment.
vol. iv
p. 433

Prerogative

of the crown are sovereignty, perfection, and perpetuity; but that it does not therefore follow that the king can do no wrong. It is indeed to be admitted, that in high respect for the crown, high respect is also due to the wearer of that crown; that is, to the king: but the crown is to be preferred to the king, for the first veneration is due to the constitution. It is likewise *to be supposed* that the king *will* do no wrong: and as, to prevent this, a privy council is appointed by the constitution to assist the king in the execution of the government; so if any wrong be done, 'these men,' as Montesquieu expresses it, 'may be examined and punished (A).'

"But if any future king shall think to screen these evil counsellors from the just vengeance of the people, by becoming *his own minister*; and, in so doing, shall take for his sanction *the attribute of perfection*, shall trust to the deception of his being *a superior being*, and cloak himself under the maxim that *the king can do no wrong*; I say, in such a case, let the appeal already made to the constitution, to nature, to reason, to common sense, to experience, to fact, to precedent, and to Sir William Blackstone himself, suffice; and preclude the necessity of any further remarks from me (B)."

To proceed now to other particulars: The law determines, that in the king can be no negligence, or LACHES; and therefore no delay will bar his right. *Nullum tempus occurrit regi*, is the standing maxim upon all occasions: for the law intends that the king is always busied for the public good, and therefore has not leisure to assert his right within the times limited to subjects. In the king also can be no stain or corruption of blood: for if the heir to the crown were attainted of treason or felony, and afterwards the crown should descend to him, this would purge the attainer *ipso facto*. And therefore, when Henry VII. who as earl of Richmond stood attainted, came to the crown, it was not thought necessary to pass an act of parliament to reverse this attainer; because, as Lord Bacon in his history of that prince informs us, it was agreed that the assumption of the crown had at once purged all attainders. Neither can the king, in judgment of law, as king, ever be a minor or under age; and therefore his royal grants and assents to acts of parliament are good, though he has not in his natural capacity attained the legal age of 21. By a statute, indeed, 28

Blackst.
Comment.

Hen. VIII. c. 17. power was given to future kings to rescind and revoke all acts of parliament that should be made while they were under the age of 24: but this was repealed by the statute 1 Edward VI. c. 11. so far as related to that prince, and both statutes are declared to be determined by 24 Geo. II. c. 24. It hath also been usually thought prudent, when the heir-apparent has been very young, to appoint a protector, guardian, or regent, for a limited time: but the very necessity of such extraordinary provision is sufficient to demonstrate the truth of that maxim of common law, that in the king is no minority; and therefore he hath no legal guardian. See REGENT.

Prerogative

3. A third attribute of the king's majesty is his *perpetuity*. The law ascribes to him, in his political capacity, an absolute immortality. The king never dies. Henry, Edward, or George, may die; but the king survives them all. For, immediately upon the decease of the reigning prince in his natural capacity, his kingship or imperial dignity, by act of law, without any *interregnum* or interval, is vested at once in his heir; who is, *eo instanti*, king to all intents and purposes. And so tender is the law of supposing even a possibility of his death, that his natural dissolution is generally called his *demise*; *dimissio regis vel coronæ*: an expression which signifies merely a transfer of property; for, as is observed in Plowden, when we say the demise of the crown, we mean only, that, in consequence of the disunion of the king's body-natural from his body-politic, the kingdom is transferred or demised to his successor, and so the royal dignity remains perpetual. Thus, too, when Edward the fourth, in the tenth year of his reign, was driven from his throne for a few months by the house of Lancaster, this temporary transfer of his dignity was denominated his *demise*; and all process was held to be discontinued, as upon a natural death of the king.

II. We are next to consider those branches of the royal prerogative which invest this our sovereign lord with a number of *authorities* and *powers*; in the exertion whereof consists the executive part of government. This is wisely placed in a single hand by the British constitution, for the sake of unanimity, strength, and dispatch. Were it placed in many hands, it would be subject to many wills: many wills, if disunited and drawing different ways, create weakness in a government; and to unite those several wills, and reduce them to one, is a work of more

(A) Except the parliament, which is the great council of the nation, the judges, and the peers, who, being the hereditary counsellors of the crown, have not only a right, but are bound *in foro conscientie* to advise the king for the public good, the constitution knows of no other counsel than the privy council. Any other counsel, like Clifford, Arlington, Buckingham, Ashley, Lauderdale, and, as the initial letters of these names express, is a CABAL, and as such should be suppressed. Nat. Bacon, speaking of the lois of power in the grand council of lords, says, "The sense of state once contracted into a privy-council, is soon recontracted into a cabinet-council, and last of all into a *favourite* or two; which many times brings damage to the public, and both *themselves* and *kings* into extreme *precipices*; partly for want of maturity, but principally through the providence of God over-ruling irregular courses to the hurt of such as walk in them." *Pol. Disc.* part 2. p. 201.

(B) For experience, fact, and precedent, see the reigns of king John, Henry III. Edward II. Richard II. Charles I. and James II. See also *Mirror of Justices*; where it is said, "that this grand assembly (meaning the now parliament, or then Wittena-gemotte) is to confer the government of God's people, how they may be kept from sin, live in quiet, and have right done them, according to the customs and laws; and more especially of *wrong done by the king*, queen, or their children:" to which Nat. Bacon adds this note: "At this time *the king might do wrong*, &c. and so say Bracton and Fleta of the *kings* in their time." *Disc.* part 1. p. 37. Lond. 1739.

Prerogative.

more time and delay than the exigencies of state will afford. The king of England is therefore not only the chief, but properly the sole, magistrate of the nation; all others acting by commission from, and in due subordination to, him: in like manner as, upon the great revolution in the Roman state, all the powers of the ancient magistracy of the commonwealth were concentrated in the new emperor; so that, as Gravina expresses it, *in ejus unius persona veteris rei publicæ vis atque majestas per cumulatæ magistratuum potestates exprimebatur*.

In the exertion of lawful prerogative the king is held to be absolute; that is, so far absolute, that there is no legal authority that can either delay or resist him. He may reject what bills, may make what treaties, may coin what money, may create what peers, may pardon what offences, he pleases: unless where the constitution hath expressly, or by evident consequence, laid down some exception or boundary; declaring, that thus far the prerogative shall go and no farther. For otherwise the power of the crown would indeed be but a name and a shadow, insufficient for the ends of government, if, where its jurisdiction is clearly established and allowed, any man or body of men were permitted to disobey it, in the ordinary course of law: we do not now speak of those extraordinary recourses to the first principles, which are necessary when the contracts of society are in danger of dissolution, and the law proves too weak a defence against the violence of fraud or oppression. And yet the want of attending to this obvious distinction has occasioned these doctrines, of absolute power in the prince and of national resistance by the people, to be much misunderstood and perverted, by the advocates for slavery on the one hand, and the demagogues of faction on the other. The former, observing the absolute sovereignty and transcendent dominion of the crown laid down (as it certainly is) most strongly and emphatically in our law-books as well as our homilies, have denied that any case can be excepted from so general and positive a rule; forgetting how impossible it is, in any practical system of laws, to point out beforehand those eccentric remedies, which the sudden emergence of national distress may dictate, and which that alone can justify. On the other hand, over-zealous republicans, feeling the absurdity of unlimited passive obedience, have fancifully (or sometimes factiously) gone over to the other extreme: and, because resistance is justifiable to the person of the prince when the being of the state is endangered, and the public voice proclaims such resistance necessary, they have therefore allowed to every individual the right of determining this expedience, and of employing private force to resist even private oppression. A doctrine productive of anarchy, and (in consequence) equally fatal to civil liberty as tyranny itself. For civil liberty, rightly understood, consists in protecting the rights of individuals by the united force of society: society cannot be maintained, and of course can exert no protection, without obedience to some sovereign power; and obedience is an empty name, if every individual has a right to decide how far he himself shall obey.

In the exertion, therefore, of those prerogatives which the law has given him, the king is irresistible and absolute, according to the forms of the constitution. And yet, if the consequence of that exertion be manifestly to the grievance or dishonour of the kingdom, the parliament will call his advisers to a just and severe account.

Blackst.
Comment.

Prerogative.

For prerogative consisting (as Mr Locke has well defined it) in the discretionary power of acting for the public good where the positive laws are silent, if that discretionary power be abused to the public detriment, such prerogative is exerted in an unconstitutional manner. Thus the king may make a treaty with a foreign state, which shall irrevocably bind the nation; and yet, when such treaties have been judged pernicious, impeachments have pursued those ministers by whose agency or advice they were concluded.

The prerogatives of the crown (in the sense under which we are now considering them) respect either this nation's intercourse with foreign nations, or its own domestic government and civil polity.

With regard to *foreign concerns*, the king is the delegate or representative of his people. It is impossible that the individuals of a state, in their collective capacity, can transact the affairs of that state with another community equally numerous as themselves. Unanimity must be wanting to their measures, and strength to the execution of their counsels. In the king therefore, as in a centre, all the rays of his people are united, and form by that union a consistency, splendor, and power, that make him feared and respected by foreign potentates; who would scruple to enter into any engagement, that must afterwards be revised and ratified by a popular assembly. What is done by the royal authority, with regard to foreign powers, is the act of the whole nation: what is done without the king's concurrence, is the act only of private men. And so far is this point carried by our law, that it hath been held, that should all the subjects of England make war with a king in league with the king of England, without the royal assent, such war is no breach of the league. And, by the statute 2 Hen. V. c. 6. any subject committing acts of hostility upon any nation in league with the king, was declared to be guilty of high treason: and, though that act was repealed by the statute 20 Hen. VI. c. 11. so far as relates to the making this offence high treason, yet still it remains a very great offence against the law of nations, and punishable by our laws, either capitally or otherwise, according to the circumstances of the case.

1. The king therefore, considered as the representative of his people, has the sole power of sending ambassadors to foreign states, and receiving ambassadors at home.

2. It is also the king's prerogative to make treaties, leagues, and alliances, with foreign states and princes. For it is, by the law of nations, essential to the goodness of a league, that it be made by the sovereign power; and then it is binding upon the whole community: and in Britain the sovereign power, *quoad hoc*, is vested in the person of the king. Whatever contracts therefore he engages in, no other power in the kingdom can legally delay, resist, or annul. And yet, lest this plenitude of authority should be abused to the detriment of the public, the constitution (as was hinted before) hath here interposed a check, by the means of parliamentary impeachment, for the punishment of such ministers as from criminal motives advise or conclude any treaty, which shall afterwards be judged to derogate from the honour and interest of the nation.

3. Upon the same principle the king has also the sole prerogative of making war and peace. For it is

Prerogative.

held by all the writers on the law of nature and nations, that the right of making war, which by nature subsisted in every individual, is given up by all private persons that enter into society, and is vested in the sovereign power: and this right is given up, not only by individuals, but even by the entire body of people that are under the dominion of a sovereign. It would indeed be extremely improper, that any number of subjects should have the power of binding the supreme magistrate, and putting him against his will in a state of war. Whatever hostilities, therefore, may be committed by private citizens, the state ought not to be affected thereby; unless that should justify their proceedings, and thereby become partner in the guilt. And the reason which is given by Grotius, why, according to the law of nations, a denunciation of war ought always to precede the actual commencement of hostilities, is not so much that the enemy may be put upon his guard (which is matter rather of magnanimity than right), but that it may be certainly clear that the war is not undertaken by private persons, but by the will of the whole community; whose right of willing is in this case transferred to the supreme magistrate by the fundamental laws of society. So that, in order to make a war completely effectual, it is necessary with us in Britain that it be publicly declared and duly proclaimed by the king's authority; and then, all parts of both the contending nations, from the highest to the lowest, are bound by it. And wherever the right resides of beginning a national war, there also must reside the right of ending it, or the power of making peace. And the same check of parliamentary impeachment, for improper or inglorious conduct, in beginning, conducting, or concluding a national war, is in general sufficient to restrain the ministers of the crown from a wanton or injurious exertion of this great prerogative.

4. But, as the delay of making war may sometimes be detrimental to individuals who have suffered by depredations from foreign potentates, our laws have in some respects armed the subject with powers to impel the prerogative; by directing the ministers of the crown to issue letters of marque and reprisal upon due demand: the prerogative of granting which is nearly related to, and plainly derived from, that other of making war; this being indeed only an incomplete state of hostilities, and generally ending in a formal denunciation of war. These letters are grantable, by the law of nations, whenever the subjects of one state are oppressed and injured by those of another, and justice is denied by that state to which the oppressor belongs. In this case, letters of marque and reprisal (words in themselves synonymous, and signifying a taking in return) may be obtained, in order to seize the bodies or goods of the subjects of the offending state, until satisfaction be made, wherever they happen to be found. And indeed this custom of reprisals seems dictated by nature herself; for which reason we find in the most ancient times very notable instances of it. But here the necessity is obvious of calling in the sovereign power, to determine when reprisals may be made; else every private sufferer would be a judge in his own cause. In pursuance of which principle, it is with us declared by the statute 4 Hen. V. c. 7. that if any subjects of the realm are oppressed in time of truce by any foreigners, the king will grant marque

in due form to all that feel themselves grieved. See Prerogative. MARQUE.

5. Upon exactly the same reason stands the prerogative of granting safe-conducts; without which, by the law of nations, no member of one society has a right to intrude into another. And therefore Puffendorf very justly resolves, that it is left in the power of all states to take such measures about the admission of strangers as they think convenient; those being ever excepted who are driven on the coasts by necessity, or by any cause that deserves pity or compassion. Great tenderness is shown by our laws, not only to foreigners in distress (see WRECK), but with regard also to the admission of strangers who come spontaneously: for so long as their nation continues at peace with ours, and they themselves behave peaceably, they are under the king's protection; though liable to be sent home whenever the king sees occasion. But no subject of a nation at war with us can, by the law of nations, come into the realm, nor can travel himself upon the high seas, or send his goods and merchandize from one place to another, without danger of being seized by our subjects, unless he has letters of safe-conduct; which, by divers ancient statutes, must be granted under the king's great seal and inrolled in chancery, or else they are of no effect; the king being supposed the best judge of such emergencies, as may deserve exception from the general law of arms. But passports under the king's sign-manual, or licences from his ambassadors abroad, are now more usually obtained, and are allowed to be of equal validity.

These are the principal prerogatives of the king respecting this nation's intercourse with foreign nations; in all of which he is considered as the delegate or representative of his people. But in domestic affairs, he is considered in a great variety of characters, and from thence there arises an abundant number of other prerogatives.

1. He is a constituent part of the supreme legislative power; and, as such, has the prerogative of rejecting such provisions in parliament as he judges improper to be passed. The expediency of which constitution has before been evinced at large under the article PARLIAMENT. We shall only farther remark, that the king is not bound by any act of parliament, unless he be named therein by special and particular words. The most general words that can be devised (any person or persons, bodies politic, or corporate, &c.) affect not him in the least, if they may tend to restrain or diminish any of his rights or interests. For it would be of most mischievous consequence to the public, if the strength of the executive power were liable to be curtailed, without its own express consent, by constructions and implications of the subject. Yet, where an act of parliament is expressly made for the preservation of public rights and the suppression of public wrongs, and does not interfere with the established rights of the crown, it is said to be binding as well upon the king as upon the subject: and, likewise, the king may take the benefit of any particular act, though he be not especially named.

2. The king is considered, in the next place, as the generalissimo, or the first in military command, within the kingdom. The great end of society is to protect the weakness of individuals by the united strength of the

Prerogative.

Prerogative

the community; and the principal use of government is to direct that united strength in the best and most effectual manner, to answer the end proposed. Monarchical government is allowed to be the fittest of any for this purpose: it follows therefore, from the very end of its institution, that in a monarchy the military power must be trusted in the hands of the prince.

In this capacity, therefore, of general of the kingdom, the king has the sole power of raising and regulating fleets and armies. The manner in which they are raised and regulated is explained under the article *MILITARY State*. We are now only to consider the prerogative of enlisting and of governing them: which indeed was disputed and claimed, contrary to all reason and precedent, by the long parliament of king Cha. I.; but, upon the restoration of his son, was solemnly declared by the statute 13 Charles II. c. 6. to be in the king alone: for that the sole supreme government and command of the militia within all his majesty's realms and dominions, and of all forces by sea and land, and of all forts and places of strength, ever was and is the undoubted right of his majesty, and his royal predecessors, kings and queens of England; and that both or either house of parliament cannot, nor ought to, pretend to the same.

This statute, it is obvious to observe, extends not only to fleets and armies, but also to forts and other places of strength within the realm; the sole prerogative, as well of erecting, as manning and governing of which, belongs to the king in his capacity of general of the kingdom: and all lands were formerly subject to a tax, for building of castles wherever the king thought proper. This was one of the three things, from contributing to the performance of which, no lands were exempted, and therefore called by the Anglo-Saxons the *trinoda necessitas*; *sc. pontis reparatio, arcis constructio, et expeditio contra hostem*. And this they were called upon to do so often, that, as Sir Edward Coke from M. Paris assures us, there were in the time of Henry II. 1115 castles subsisting in England. The inconveniences of which, when granted out to private subjects, the lordly barons of those times, were severely felt by the whole kingdom; for, as William of Newburgh remarks in the reign of king Stephen, *erant in Anglia quodammodo tot reges, vel potius tyranni, quot domini castellorum*; but it was felt by none more sensibly than by two succeeding princes, king John and king Henry III. And therefore, the greatest part of them being demolished in the baron's wars, the kings of after times have been very cautious of suffering them to be rebuilt in a fortified manner: and Sir Edward Coke lays it down, that no subject can build a castle, or house of strength im-battled, or other fortrefs defensible, without the licence of the king; for the danger which might ensue, if every man at his pleasure might do it.

It is partly upon the same, and partly upon a fiscal foundation, to secure his marine revenue, that the king has the prerogative of appointing *ports* and *havens*, or such places only, for persons and merchandize to pass into and out of the realm, as he in his wisdom sees proper. By the feudal law, all navigable rivers and havens were computed among the regalia, and were subject to the sovereign of the state. And in England it hath always been held, that the king is lord of the whole shore, and particularly is the guardian of the ports and havens,

Prerogative

which are the inlets and gates of the realm: and therefore, so early as the reign of king John, we find ships seized by the king's officers for putting in at a place that was not a legal port. These legal ports were undoubtedly at first assigned by the crown; since to each of them a court of portmote is incident, the jurisdiction of which must flow from the royal authority: the *great ports* of the sea are also referred to, as well known and established, by statute 4 Hen. IV. c. 20. which prohibits the landing elsewhere under pain of confiscation: and the statute 1 Eliz. c. 11. recites, that the franchise of lading and discharging had been frequently granted by the crown.

But though the king had a power of granting the franchise of havens and ports, yet he had not the power of resumption, or of narrowing and confining their limits when once established; but any person had a right to load or discharge his merchandize in any part of the haven: whereby the revenue of the custom was much impaired and diminished, by fraudulent landings in obscure and private corners. This occasioned the statutes of 1 Eliz. c. 11. and 13 and 14 Car. II. c. 11. § 14. which enable the crown by commission, to ascertain the limits of all ports, and to assign proper wharfs and quays in each port, for the exclusive landing and loading of merchandize.

The erection of beacons, light-houses, and sea-marks, is also a branch of the royal prerogative: whereof the first was anciently used in order to alarm the country, in case of the approach of an enemy; and all of them are signally useful in guiding and preserving vessels at sea by night as well as by day. See *BEACON*.

3. Another capacity in which the king is considered in domestic affairs, is as the fountain of justice and general conservator of the peace of the kingdom. See the article *Fountain of Justice*.

4. The king is likewise the fountain of honour, of office, and of privilege: and this in a different sense from that wherein he is styled the *fountain of justice*; for here he is really the parent of them. See the articles *Fountain of Justice* and *Fountain of Honour*.

5. Another light, in which the laws of England consider the king with regard to domestic concerns, is as the arbiter of commerce. By commerce, we at present mean domestic commerce only; for the king's prerogative with regard to which, see *Regulation of Weights and Measures*, *MONEY*, &c.

6. The king is, lastly, considered by the laws of England as the head and supreme governor of the national church.

To enter into the reasons upon which this prerogative is founded is matter rather of divinity than of law. We shall therefore only observe, that by statute 26 Hen. VIII. c. 1. (reciting that the king's majesty justly and rightfully is and ought to be the supreme head of the church of England; and so had been recognised by the clergy of that kingdom in their convocation) it is enacted, that the king shall be reputed the only supreme head in earth of the church of England; and shall have, annexed to the imperial crown of this realm, as well the title and style thereof, as all jurisdictions, authorities, and commodities, to the said dignity of supreme head of the church appertaining. And another statute to the same purport was made, 1 Eliz. c. 1.

In virtue of this authority the king convenes, pro-
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Prerogative
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Presburg

rogues, restrains, regulates, and dissolves, all ecclesiastical synods or convocations. This was an inherent prerogative of the crown long before the time of Henry VIII. as appears by the statute 8 Hen. VI. c. 1. and the many authors, both lawyers and historians, vouched by Sir Edward Coke. So that the statute 25 Hen. VIII. c. 19. which restrains the convocation from making or putting in execution any canons repugnant to the king's prerogative, or the laws, customs, and statutes of the realm, was merely declaratory of the old common law: that part of it only being new, which makes the king's royal assent actually necessary to the validity of every canon. The convocation or ecclesiastical synod, in England, differs considerably in its constitution from the synods of other Christian kingdoms: those consisting wholly of bishops; whereas in England the convocation is the miniature of a parliament, wherein the archbishop presides with regal state; the upper house of bishops represents the house of lords; and the lower house, composed of representatives of the several dioceses at large, and of each particular chapter therein, resembles the house of commons with its knights of the shire and burgesses. This constitution is said to be owing to the policy of Edward I. who thereby at one and the same time let in the inferior clergy to the privileges of forming ecclesiastical canons (which before they had not), and also introduced a method of taxing ecclesiastical benefices, by consent of convocation.

From this prerogative also, of being the head of the church, arises the king's right of nomination to vacant bishoprics, and certain other ecclesiastical preferments.

As head of the church, the king is likewise the *demer resort* in all ecclesiastical causes; an appeal lying ultimately to him in chancery from the sentence of every ecclesiastical judge: which right was restored to the crown by statute 25 Hen. VIII. c. 9.

III. The king's fiscal prerogatives, or such as regard his revenue. See the article REVENUE.

PREROGATIVE-COURT, an English court established for the trial of all testamentary causes, where the deceased hath left *bona notabilia* within two different dioceses. In which case the probate of wills belongs to the archbishop of the province, by way of special prerogative. And all causes relating to the wills, administrations, or legacies of such persons, are originally cognizable herein, before a judge appointed by the archbishop, called the *judge of the prerogative-court*; from whom an appeal lies by statute 25 Hen. VIII. c. 19. to the king in chancery, instead of the pope as formerly.

PRESAGE, in antiquity, denotes an augury, or sign of some future event; which was chiefly taken from the flight of birds, the entrails of victims, &c. See AUGURY and ARUSPICES.

PRESBURG, the capital of the kingdom of Lower Hungary, called by the inhabitants *Pöseny* and *Prešporen*, situated on the Danube, about 46 miles east from Vienna, and 75 from Buda. The castle, in which the regalia are kept, stands on a hill above the town. Here the states assemble; and in the cathedral, dedicated to St Martin, the king is crowned. The town is not very large, nor well built; but is very ancient, pleasantly situated, and enjoys a good air. Its fortifications are only a double wall and ditch. In the lower suburbs is a hill, where the king, after his coronation, goes on horseback, and brandishes St Stephen's sword towards the four car-

dinal points, intimating, that he will defend his country against all its enemies. Besides the cathedral, there are several other Popish and one Lutheran church, with a Jesuits college, three convents, and two hospitals. It gives name to a county; and is the residence of the archbishop of Gran, who is primate, chief secretary, and chancellor of the kingdom, *legatus natus* of the Papal see, and prince of the holy Roman empire. E. Long. 17. 30. N. Lat. 48. 20.

PRESBYTÆ, persons whose eyes are too flat to refract the rays sufficiently, so that unless the object is at some distance, the rays coming from it will pass through the retina before their union, consequently vision is confused; old people are usually the subjects of this disease. In order to remedy, or at least to palliate, this defect, the person should first use glasses which do not magnify, and from them pass gradually to more convex spectacles, which shorten the focus.

PRESBYTER, in the primitive Christian church, an elder, one of the second order of ecclesiastics; the other two being bishops and deacons. See the articles BISHOP and DEACON.

Presbyter or elder is a word borrowed from the Greek translation of the Old Testament, where it commonly signifies ruler or governor; it being a note of office and dignity, not of age; and in this sense bishops are sometimes called *presbyters* in the New Testament. The presbyters might baptize, preach, consecrate, and administer the eucharist in the bishop's absence, or in his presence if he authorised and deputed them; and the bishops did scarce any thing in the government of the church without their advice, consent, and amicable concurrence.

The grand dispute between the followers of the Geneva and Roman discipline, is about the sameness and difference of presbyters and bishops at the time of the apostles. See EPISCOPACY, INDEPENDENTS, and the following article.

PRESBYTERIANS, Protestants, so called from their maintaining that the government of the church appointed in the New Testament was by presbyteries, that is, by associations of ministers and ruling elders, possessed all of equal powers, without any superiority among them either in office or in order. Discriminating principle of the Presbyterians.

The Presbyterians believe, that the authority of their ministers to preach the gospel, to administer the sacraments of baptism and the Lord's supper, and to feed the flock of Christ, is derived from the Holy Ghost by the imposition of the hands of the presbytery; and they oppose the independent scheme of the common rights of Christians by the same arguments which are used for that purpose by the Episcopalians (see EPISCOPACY). They affirm, however, that there is no order in the church as established by Christ and his apostles superior to that of presbyters; that all ministers being ambassadors of Christ, are equal by their commission; that *presbyter* and *bishop*, though different words, are of the same import; and that prelacy was gradually established upon the primitive practice of making the *moderator* or speaker of the presbytery a permanent officer.

These positions they maintain against the Episcopalians by the following scriptural arguments. They observe, that the apostles planted churches by ordaining bishops and deacons in every city; that the ministers which in one verse are called bishops are in the next perhaps

Presbyter
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Presbyterians.

Presby-
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perhaps denominated presbyters; that we nowhere read in the New Testament of bishops, presbyters, and deacons, in any one church; and that therefore we are under the necessity of concluding *bishop* and *presbyter* to be two names for the same church officer. This is apparent from Peter's exhortation to the *elders* or *presbyters* who were among the Jewish Christians. "The *elders* (presbyters) which are among you I exhort, who am also an *elder*, and a witness of the sufferings of Christ, and also a partaker of the glory that shall be revealed: Feed the flock of God which is among you, taking the oversight thereof (*ἐπισκοποῦντες* acting as *bishops* thereof), not by constraint, but willingly; not for filthy lucre, but of a ready mind; neither as being lords over God's heritage, but being ensamples to the flock*." From this passage it is evident, that the presbyters not only fed the flock of God, but also governed that flock with episcopal powers; and that the apostle himself, as a church officer, was nothing more than a presbyter or elder. The identity of the office of bishop and presbyter is still more apparent from Heb. xiii. 7. 17. and 1 Thess. v. 12.; for the bishops are there represented as governing the flock, speaking to them the word of God, watching for their souls, and discharging various offices, which it is impossible for any man to perform to more than one congregation.

* 1. Peter
v. 1, 2, 3.3
Reasons for
supposing
bishops and
presbyters
of the same
order.† Chap. v.
14.

From the last cited text it is evident, that the bishops (*ἐπισκοποι*) of the Thessalonian churches had the pastoral care of no more souls than they could hold personal communion with in God's worship; for they were such as all the people were to know, esteem, and love, as those that not only were over them, but also "closely laboured among them and admonished them." But diocesan bishops, whom ordinarily the hundredth part of their flock never hear nor see, cannot be those bishops by whom that flock is admonished, nor can they be what Peter requires the bishops of the Jewish converts to be *ensamples to the flock*. It is the opinion of Dr Hammond, who was a very learned divine, and a zealot for episcopacy, that the *elders* whom the apostle James desires† the sick to call for, were of the highest permanent order of ecclesiastical officers; but it is self-evident that those elders cannot have been diocesan bishops, otherwise the sick must have been often without the reach of the remedy proposed to them.

There is nothing in Scripture upon which the Episcopalian is more ready to rest his cause than the alleged episcopacy of Timothy and Titus; of whom the former is said to have been bishop of Ephesus, and the latter bishop of Crete; yet the Presbyterian thinks it as clear as the noon-day sun, that the presbyters of Ephesus were supreme governors under Christ of the Ephesian churches, at the very time that Timothy is pretended to have been their proper diocesan.

In Acts xx. 17, &c. we read, that "from Miletus Paul sent to Ephesus, and called the elders (presbyters) of the church. And when they were come to him, he said unto them, Ye know, from the first day that I came into Asia, after what manner I have been with you, at all seasons. And now I know that ye all, among whom I have gone preaching the kingdom of God, shall see my face no more. Wherefore I take you to record this day, that I am pure from the blood of all men. For I have not shunned to declare unto you all the counsel of God. Take heed therefore unto

yourself, and to all the flock over which the Holy Ghost hath made you overseers (*ἐπισκοπους bishops*), to feed the church of God, which he hath purchased with his own blood. For I know this, that after my departure shall grievous wolves enter in among you, not sparing the flock. Also of your own selves shall men arise, speaking perverse things, to draw away disciples after them. Therefore watch, and remember, that by the space of three years, I ceased not to warn every one night and day with tears. And now, brethren, I recommend you to God, and to the word of his grace," &c.

Presby-
terians.

From this passage, it is evident that there was in the city of Ephesus a plurality of pastors of equal authority without any superior pastor or bishop over them; for the apostle directs his discourse to them all in common, and gives them equal power over the whole flock. Dr Hammond indeed imagines, that the elders whom Paul called to Miletus were the *bishops* of Asia, and that he sent for them to Ephesus, because that city was the metropolis of the province. But were this opinion well-founded, it is not conceivable that the sacred writer would have called them the elders of the church of Ephesus, but the elders of the church in general, or the elders of the churches in Asia. Besides, it is to be remembered, that the apostle was in such haste to be at Jerusalem, that the sacred historian measures his time by days; whereas it must have required several months to call together the bishops or elders of all the cities of Asia; and he might certainly have gone to meet them at Ephesus in less time than would be requisite for their meeting in that city and proceeding thence to him at Miletus. They must therefore have been either the joint pastors of one congregation, or the pastors of different congregations in one city: and as it was thus in Ephesus, so was it in Philippi; for we find the apostle addressing his epistle "to all the saints in Christ Jesus which are at Philippi, with the bishops and deacons." From the passage before us it is likewise plain, that the presbyters of Ephesus had not only the name but the whole power of bishops given to them by the Holy Ghost; for they are enjoined to do the whole work of bishops—*ἐπισκοπεῖν τὴν ἐκκλησίαν τοῦ θεοῦ*—which signifies, to rule as well as feed the church of God. Whence we see, that the apostle makes the power of governing inseparable from that of preaching and watching; and that according to him, all who are preachers of God's word, and watchmen of souls, are necessarily rulers or governors of the church, without being accountable for their management to any prelate, but only to their Lord Christ from whom their power is derived.

It appears therefore, that the apostle Paul left in the Timothy church of Ephesus, which he had planted, no other successors to himself than *presbyter-bishops* or Presbyterian ministers, and that he did not devolve his power upon any prelate. Timothy, whom the Episcopalians allege to have been the first bishop of Ephesus, was present when this settlement was made*; and it is surely not to be supposed, that, had he been their bishop, the apostle would have devolved the whole episcopal power upon the presbyters before his face. If ever there was a season fitter than another for pointing out the duty of this supposed bishop to his diocese, and his presbyters duty to him, it was surely when Paul was taking his final leave of them, and discoursing so pathetically concerning

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The pastors
of Ephesus
of equal
authority.5
no bishop,

* Acts xxi.

Presby-
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cerning the duty of *overseers*, the coming of ravenous wolves, and the consequent hazard of the flock. In this farewell discourse, he tells them that "he had not shunned to declare unto them all the counsel of God." But with what truth could this have been said, if obedience to a diocesan bishop had been any part of their duty either at the time of the apostle's speaking or at any future period? He foresaw that ravenous wolves would enter in among them, and that even some of themselves should arise speaking perverse things; and if, as the Episcopalians allege, diocesan episcopacy was the remedy provided for those evils, is it not strange, passing strange, that the inspired preacher did not foresee that Timothy, who was standing beside him, was destined to fill that important office; or if he did foresee it, that he omitted to recommend him to his future charge, and to give him proper instructions for the discharge of his duty?

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But an e-
vangelist.

† 2 Tim.
4. 5.

‡ Phil. ii.
19.
1 Cor. iv.
17. xvi. 10.
11.

* 1 Tim.
i. 3.

7
Presby-
terate the
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But if Timothy was not bishop of Ephesus, what, it may be asked, was his office in that city? for that he resided there for some time, and was by the apostle invested with authority to ordain and rebuke presbyters, are facts about which all parties are agreed, and which indeed cannot be controverted by any reader of Paul's epistles. To this the Presbyterian replies with confidence, that the power which Timothy exercised in the church of Ephesus was that of an evangelist †, and not a fixed prelate. But, according to Eusebius, the work of an evangelist was, "to lay the foundations of the faith in barbarous nations, and to constitute among them pastors; after which he passed on to other countries." Accordingly we find, that Timothy was resident for a time at Philippi and Corinth ‡ as well as at Ephesus, and that he had as much authority over those churches as over that of which he is said to have been the fixed bishop. "Now, if Timotheus come, see that he may be with you without fear, for he worketh the work of the Lord, as I also do. Let no man therefore despise him." This text might lead us to suppose, that Timothy was bishop of Corinth as well as of Ephesus; for it is stronger than that upon which his episcopacy of the latter church is chiefly built. The apostle says, "I besought thee* to abide still at Ephesus, when I went into Macedonia, that thou mightest charge some that they teach no other doctrine." But had Timothy been the fixed bishop of that city, there would surely have been no necessity for *beseeching* him to abide with his flock. It is to be observed, too, that the first epistle to Timothy, which alone was written to him during his residence at Ephesus, was of a date prior to Paul's meeting with the elders of that church at Miletus; for in the epistle he hopes to come to him shortly, whereas he tells the elders at Miletus that they should see his face no more. This being the case, it is evident that Timothy was left by the apostle at Ephesus only to supply his place during his temporary absence at Macedonia, and that he could not possibly have been constituted fixed bishop of that church, since the episcopal powers were afterwards committed to the presbyters by the Holy Ghost in his presence.

The identity of the office of bishop and presbyter being thus clearly established, it follows, that the presbyterate is the highest permanent office in the church, and that every faithful pastor of a flock is successor to the apostles in every thing in which they were to have

any successors. In the apostolic office there were indeed some things peculiar and extraordinary, such as their immediate call by Christ, their infallibility, their being witnesses of our Lord's resurrection, and their unlimited jurisdiction over the whole world. These powers and privileges could not be conveyed by imposition of hands to any successors, whether called presbyters or bishops; but as rulers or office-bearers in particular churches, we have the confession of "the very chiefest apostles," Peter and John, that they were nothing more than presbyters or parish ministers. This being the case, the dispute, which in the early part of the passing century was so warmly agitated concerning the validity of Presbyterian ordination, may be soon decided; for if the ceremony of ordination be at all essential, it is obvious that such a ceremony performed by presbyters must be valid, as there is no higher order of ecclesiastics in the church by whom it can be performed. Accordingly we find, that Timothy himself, though said to be a bishop, was ordained by the laying on of the hands of a presbytery. At that ordination indeed St Paul presided, but he could preside only as *primus in paribus*; for we have seen that, as permanent officers in the church of Christ, the apostles themselves were no more than presbyters. If the apostles hands were imposed for any other purpose, it must have been to communicate those *charismata* or miraculous gifts of the Holy Spirit, which were then so frequent; but which no modern presbyter or bishop will pretend to give, unless his understanding be clouded by the grossest ignorance, or perverted by the most frantic enthusiasm.

But if the office of bishop and presbyter was originally the same, how, it will be asked, came diocesan episcopacy to prevail so universally as it is confessed to have done before the conversion of Constantine and the civil establishment of Christianity in the Roman empire? To give a satisfactory answer to this question is certainly the most arduous task which the advocate for presbytery has to perform; but it is a task not insurmountable.

From many passages in the New Testament *, it is evident, that when the apostles planted churches in different cities, they generally settled more than one pastor in the same church, to feed and govern it with joint authority. The propriety of this constitution is obvious. In those days, when the disciples of Christ were persecuted for their religion, and often obliged to meet in the "night for fear of the Jews," they could not with any degree of prudence assemble in large numbers; and therefore, had there been no more than one pastor in a city, the Christian converts, though, when assembled, they might have amounted to but a small congregation, could not all have enjoyed the benefit of public worship on the same day; at least it is obvious that they could not possibly have assembled for this purpose so often as their want of instruction, and the duty of "breaking of bread and of prayer," required them to meet. It was therefore with great wisdom that the apostles ordained several presbyters in the same church; but as these presbyters would have occasion to meet frequently, and to deliberate on the state of the flock which it was their duty to feed, and over which they had all equal authority, they would be under the necessity of electing one of their own
number

Presby-
terians.

8
Rise of e-
piscopacy.

* Acts xi.
29. xiii. 1.
2, 3. xv.
Tit. i. 5.

Presbyterians.

Presbyterians.

7 Acts xv.

9
According to Jerome.

number to be president or *moderator* of the presbytery, that order might be preserved, and all things done with decency. At first there is reason to believe that those presidents held their office no longer than while the presbyteries sat in which they were elected. Among the apostles themselves there was no fixed president. Peter indeed appears to have been most frequently admitted to that honour; but there is one very memorable occasion on record†, when James the Lord's brother presided in an assembly of apostles, elders, and brethren, held at Jerusalem, to determine the question concerning the necessity of circumcising the Gentiles, and commanding them to keep the law of Moses.

Upon this model were the primitive presbyteries formed. They consisted of several presbyters possessed of equal powers, who at their meetings appointed one of their own number to discharge the office of moderator or temporary president; but to this president they gave no prelatical powers or negative voice over the deliberations of his brethren; for, as Jerome informs us, the church was then governed *communi presbyterorum consilio*, "by a common council of presbyters." It appears, however, that when an apostle, an apostolical man, or an evangelist, fixed his residence in any city, and took upon himself the pastoral care of part of the flock, his co-presbyters, from respect to his singular gifts, made him their constant and fixed moderator. Hence Timothy, during his abode at Ephesus, was moderator of the presbytery; and hence too Mark the evangelist, who resided many years in Alexandria, has been called the first bishop of that church, though he appears to have been nothing more than permanent moderator. We advance this upon the authority of Jerome, one of the most learned fathers of the Christian church, who informs us, that upon the death of the evangelist, the presbyters of Alexandria, for more than 200 years, chose their bishops from their own number, and placed them in the episcopal chair, without dreaming that they ought to be raised to a higher order by a new consecration;—*Presbyteri unum ex se electum in excelsiori gradu collocatum, episcopum nominabant*. As this practice of making the moderator of the presbytery of Alexandria a permanent officer, was thought a good expedient to guard the infant churches against schisms and divisions, those churches gradually adopted it. For, as Jerome tells us, *Postquam unusquisque eos quos baptizaverat, suos putabat esse, non Christi, in toto orbe decretum est, ut unus de presbyteris electus, superponeretur ceteris, ad quem omnis ecclesia cura pertineret, et schismatum semina tollerentur*.

The advantages which, in displaying his talents and authority, the perpetual president or speaker of any assembly has over his colleagues in office, are so obvious, that when the practice of electing their moderators for life became universal among the presbyteries of the primitive church, it is easy to conceive how ambitious men might so magnify the difficulties and importance of their station, as to introduce the custom of filling it by a new consecration of the bishop elect. But when this was done, diocesan episcopacy, with all its powers and prerogatives, would follow as a thing of course, until "by little and little (as Jerome expresses himself) the whole pastoral care of the flock was devolved upon one man."

Our limits will not permit us to trace more minutely
VOL. XV. Part II.

the rise and progress of this ecclesiastical usurpation, as the Presbyterian calls it; but the reader who wishes for fuller information, after studying the remains of the four first centuries of the Christian church, may consult *An Inquiry into the Constitution, Discipline, and Worship, of the Primitive Church*, said to have been written by Sir Peter King, afterwards lord chancellor of England. As an impartial lover of truth, he will do well to consult also a book intitled *An original Draught of the Primitive Church*, which was published as an answer to the Inquiry; and he may read with much advantage to himself *A Letter from a parochial bishop to a prelatical gentleman, with An Apology for the church of Scotland*, both written by Mr Willison some time minister in Dundee, and both evincing considerable learning and great ingenuity in their pious author.

Of the churches at present formed upon this model, we believe, that without incurring the imputation of national prejudice, we may safely affirm the church of Scotland to be by much the most respectable. Her mode of worship is simple and solemn; her established faith agreeable to the confessions of most other Protestant churches; her judicatories are calculated to maintain the rights of the people; and her pastors are confessedly men of liberal and enlightened minds. On these accounts it appears to us, that we cannot more properly conclude this article than with a short view of her constitution, as being that in which our Presbyterian readers are undoubtedly most interested.

No one is ignorant, that from the first dawn of reformation among us, till the era of the revolution, there was a perpetual struggle between the court and the people for the establishment of an Episcopal or a Presbyterian form of church government: The former model of ecclesiastical polity was patronised by the house of Stuart on account of the support which it gave to the prerogatives of the crown; the latter was the favourite of the majority of the people, perhaps not so much on account of its superior claim to apostolical institution, as because the laity are mixed with the clergy in church judicatories, and the two orders, which under episcopacy are kept so distinct, incorporated, as it were, into one body. In the Scottish church, every regulation of public worship, every act of discipline, and every ecclesiastical censure, which in other churches flows from the authority of a diocesan bishop, or from a convocation of the clergy, is the joint work of a certain number of clergymen and laymen acting together with equal authority, and deciding every question by a plurality of voices. The laymen who thus form an essential part of the ecclesiastical courts of Scotland, are called *ruling elders*; and hold the same office, as well as the same name, with those brethren* who joined with the apostles and elders at Jerusalem in determining the important question concerning the necessity of imposing upon the Gentile converts the ritual observances of the law of Moses. These lay-elders Paul enjoined Timothy§ to account worthy of double honour, if they should rule well, and discharge the duties for which they were separated from the multitude of their brethren. In the church of Scotland every parish has two or three of those lay-elders, who are grave and serious persons chosen from among the heads of families, of known orthodoxy and steady adherence to the worship, discipline, and government of the church. Be-

† Governed by clergymen and laymen.

* Acts xv.

§ 1 Tim. v. 17.

Presby-
terians.

ing solemnly engaged to use their utmost endeavours for the suppression of vice and the cherishing of piety and virtue, and to exercise discipline faithfully and diligently, the minister, in the presence of the congregation, sets them apart to their office by solemn prayer; and concludes the ceremony, which is sometimes called ordination, with exhorting both elders and people to their respective duties.

12
The kirk-
session.

The kirk-session, which is the lowest ecclesiastical judicatory, consists of the minister and those elders of the congregation. The minister is *ex officio* moderator, but has no negative voice over the decision of the session; nor indeed has he a right to vote at all, unless when the voices of the elders are equal and opposite. He may indeed enter his protest against their sentence, if he think it improper, and appeal to the judgment of the presbytery; but this privilege belongs equally to every elder, as well as to every person who may believe himself aggrieved by the proceedings of the session. The deacons, whose proper office it is to take care of the poor, may be present in every session, and offer their counsel on all questions that come before it; but except in what relates to the distribution of alms, they have no decisive vote with the minister and elders.

13
The pres-
bytery.

The next judicatory is the *presbytery*, which consists of all the pastors within a certain district, and one ruling elder from each parish commissioned by his brethren to represent, in conjunction with the minister, the session of that parish. The presbytery treats of such matters as concern the particular churches within its limits; as the examination, admission, ordination, and censuring of ministers; the licensing of probationers, rebuking of gross or contumacious sinners, the directing of the sentence of excommunication, the deciding upon references and appeals from kirk-sessions, resolving cases of conscience, explaining difficulties in doctrine or discipline; and censuring, according to the word of God, any heresy or erroneous doctrine which hath been either publicly or privately maintained within the bounds of its jurisdiction. Partial as we may be thought to our own church, we frankly acknowledge that we cannot altogether approve of that part of her constitution which gives an equal vote, in questions of heresy, to an illiterate mechanic and his enlightened pastor. We are persuaded that it has been the source of much trouble to many a pious clergyman; who, from the laudable desire of explaining the scriptures and declaring to his flock all the counsel of God, has employed a variety of expressions of the same import, to illustrate those articles of faith, which may be obscurely expressed in the established standards. The fact however is, that, in presbyteries, the only prerogatives which the pastors have over the ruling elders, are the power of ordination by imposition of hands, and the privilege of having the moderator chosen from their body.

14
The pro-
vincial syn-
od.

From the judgment of the presbytery there lies an appeal to the provincial synod, which ordinarily meets twice in the year, and exercises over the presbyteries within the province a jurisdiction similar to that which is vested in each presbytery over the several kirk-sessions within its bounds. Of these synods there are in the church of Scotland fifteen, which are composed of the members of the several presbyteries within the respective provinces which give names to the synods.

The highest authority in the church of Scotland is

the general assembly, which consists of a certain number of ministers and ruling elders delegated from each presbytery, and of commissioners from the universities and royal boroughs. A presbytery in which there are fewer than twelve parishes, sends to the general assembly two ministers and one ruling elder: if it contain between 12 and 18 ministers, it sends three of these, and one ruling elder: if it contain between 18 and 24 ministers, it sends four ministers and two ruling elders; and of 24 ministers, when it contains so many, it sends five with two ruling elders. Every royal borough sends one ruling elder, and Edinburgh two; whose election must be attested by the kirk-sessions of their respective boroughs. Every university sends one commissioner from its own body. The commissioners are chosen annually six weeks before the meeting of the assembly; and the ruling elders are often men of the first eminence in the kingdom for rank and talents. In this assembly, which meets once a year, the king presides by his commissioner, who is always a nobleman; but he has no voice in their deliberations. The order of their proceedings is regular, though sometimes the number of members creates a confusion, which the moderator, who is chosen from among the ministers to be, as it were, the speaker of the house, has not sufficient authority to prevent. Appeals are brought from all the other ecclesiastical courts in Scotland to the general assembly; and in questions purely religious no appeal lies from its determinations.—In the subordination of these assemblies, parochial, presbyterial, provincial, and national, the less unto the greater, consists the external order, strength, and steadfastness of the church of Scotland.

PRESCIENCE, in theology, prevision, or foreknowledge; that knowledge which God has of things to come.—The doctrine of predestination is founded on the prescience of God, and on the supposition of all futurity's being present to him. See PREDESTINATION.

PRESCRIPTION, in medicine, is the assigning a proper and adequate remedy to the disease, from an examination of its symptoms, and an acquaintance with the virtues and effects of the materia medica.

PRESCRIPTION, in law, is a title acquired by use and time, and allowed by law; as when a man claims any thing, because he, his ancestors, or they whose estate he hath, have had or used it all the time whereof no memory is to the contrary: or it is where for continuance of time, *ultra memoriam hominis*, a particular person hath a particular right against another.

There is a difference between prescription, custom, and usage. *Prescription* hath respect to a certain person, who by *intendment* may have continuance for ever; as for instance, he and all they whose estate he hath in such a thing, this is a prescription: but, *Custom* is local, and always applied to a certain place; as, *time out of mind there has been such a custom in such a place, &c.* And *prescription* belongeth to one or a few only; but *custom* is common to all. *Usage* differs from both, for it may be either to persons or places; as to inhabitants of a town to have a way, &c.

A custom and prescription are in the right: usage is in the possession; and a prescription that is good for the matter and substance, may be bad by the manner of setting it forth: but where that which is claimed as a custom, in or for many, will be good, that regularly will be so when claimed by prescription for one. *Prescription* is to

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be *time out of mind*; though it is not the length of time that begets the right of prescription, nothing being done by time, although every thing is done in time; *but it is a presumption in law, that a thing cannot continue so long quiet, if it was against right, or injurious to another.*

PRESCRIPTION, in Scotch law. See LAW, p. 698, and 725.

PRESCRIPTION, in theology, was a kind of argument pleaded by Tertullian and others in the 3d century against erroneous doctors. This mode of arguing has been despised by some, both because it has been used by Papists, and because they think that truth has no need of such a support. But surely in disputed points, if it can be shown that any particular doctrine of Christianity was held in the earliest ages, even approaching the apostolic, it must have very considerable weight; and indeed that it has so, appears from the universal appeals of all parties to those early times in support of their particular opinions. Besides, the thing is in itself natural; for if a man finds a variety of opinions in the world upon important passages in scripture, where shall he be so apt to get the true sense as from cotemporary writers or others who lived very near the apostolic age? and if such a man shall find any doctrine or interpretation to have been universally believed in the first ages, or as Vincentius Lirinensis words it, *semper ubique et ab omnibus*, he will unquestionably be disposed to think such early and universal consent, or such prescription, of very considerable weight in determining his opinion.

PRESENCE, a term of relation, used in opposition to absence, and signifying the existence of a person in a certain place.

PRESENT Tense, in grammar, the first tense of a verb, expressing the present time, or that something is now performing; as *scribo*, I write, or am writing. See GRAMMAR.

PRESENTATION, in ecclesiastical law. See PATRONAGE.

PRESSENTATION of the Virgin, is a feast of the Romish church, celebrated on the 21st of November, in memory of the Holy Virgin's being presented by her parents in the temple, to be there educated. Emanuel Comnenus, who began to reign in 1143, makes mention of this feast in his Constitution. Some imagine it to have been established among the Greeks in the 11th century; and think they see evident proofs of it in some homilies of George of Nicomedia, who lived in the time of Phottius. Its institution in the West is ascribed to Gregory XI. in 1372. Some think it was instituted in memory of the ceremony practised among the Jews for their newborn females; corresponding to the circumcision on the eighth day for males.

PRESSENTATION of our Lady also gives the title to three orders of nuns. The first, projected in 1618, by a maid named Joan of Cambray. The habit of the nuns, according to the vision she pretended to have, was to be a grey gown of natural wool, &c.; but this project was never accomplished. The second was established in France, about the year 1627, by Nicholas Sanguin, bishop of Senlis; it was approved by Urban VIII. This order never made any great progress. The third was established in 1664, when Frederic Borromeo, being apostolical visitor in the Valteline, was intreated by some devout maids at Morbegno to allow them to live in community in a retired place; which he granted, and erec-

ted them into a congregation, under the title of *congregation of our Lady*. They live under the rule of St Augustine.

PRESENTMENT, in law. See PROSECUTION.

A presentment, generally taken, is a very comprehensive term; including not only *presentments* properly so called, but also inquisitions of office, and indictments by a grand jury. A presentment, properly speaking, is the notice taken by a grand jury of any offence from their own knowledge or observation, without any bill of indictment laid before them at the suit of the king: As the presentment of a nuisance, a libel, and the like; upon which the officer of the court must afterwards frame an indictment, before the party presented can be put to answer it. An inquisition of office is the act of a jury, summoned by the proper officer to inquire of matters relating to the crown, upon evidence laid before them. Some of these are in themselves convictions, and cannot afterwards be traversed or denied; and therefore the inquest, or jury, ought to hear all that can be alleged on both sides. Of this nature are all inquisitions of *felo de se*; of flight in persons accused of felony; of deodands, and the like; and presentments of petty offences in the sheriff's tourn or court-leet, whereupon the presiding officer may set a fine. Other inquisitions may be afterwards traversed and examined; as particularly the coroner's inquisition of the death of a man, when it finds any one guilty of homicide; for in such cases the offender so presented must be arraigned upon this inquisition, and may dispute the truth of it; which brings it to a kind of indictment, the most usual and effectual means of prosecution. See INDICTMENT.

PRESIDENT, PRÆSES, is an officer created or elected to preside over a company or assembly; so called in contradistinction to the other members, who are termed *residents*.

LORD PRESIDENT of the Council, is a great officer of the crown, who has precedence next after the lord chancellor and lord treasurer; as ancient as the time of King John, when he was styled *consiliarius capitalis*.—His office is to attend on the king, to propose business at the council-table, and to report to the king the several transactions there. See PRIVY-COUNCIL.

PRESIDIAL, was a tribunal, or bench of judges, established (before the Revolution) in the several considerable cities of France, to judge ultimately, or in the last resort, of the several causes brought before them by way of appeal from the subaltern judges. The presidials made one company with the officers of the bailliages and seneschauffees, where they were established.

PRESS (PRELUM), in the mechanic arts, a machine made of iron or wood, serving to squeeze or compress any body very close.

The ordinary presses consist of six members, or pieces; viz. two flat smooth planks; between which the things to be pressed are laid; two screws, or worms, fastened to the lower plank, and passing through two holes in the upper; and two nuts, in form of an S, serving to drive the upper plank, which is moveable, against the lower, which is stable, and without motion.

PRESSES used for expressing of Liquors, are of various kinds; some, in most respects, the same with the common presses, excepting that the under plank is per-

Present-
ment
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P. ess.

Press. forated with a great number of holes, to let the juice expressed run through into a tub, or receiver, underneath.

A very useful machine for a press, in the process of cyder-making, has been lately constructed by Mr Anslie, who, with his well-known zeal for the improvement of mechanics, permits us to lay before our readers the following description of it.

Plate
CCCCXV. AA, n^o 1. two pieces of timber, 21 feet long, 12 by 6 inches, laid side by side at the distance of 12 inches, and secured in that situation by blocks placed between and bolts passing through them; this frame forms the bed of the machine. BB, two uprights, 12 feet long, 6 by 8 inches, morticed upon them, and secured in their position by pins and iron squares. CC, two uprights, five feet long, six by 10 inches, morticed near the end of the under frame, and secured as before. D, a lever, 17 feet long, 12 by 13 inches, turning on a large bolt which passes through the short uprights, also through iron straps, which secure them to the bed inside, and a stirrup of iron which passes over the end of the lever, and which makes the turning point in the line of its lower side, and not through its middle. E, a lever 20 feet long, six by eight inches at its largest part, and tapering towards the other end: this lever turns on a bolt in the uprights BB. F, 1, 2, 3, 4. four pieces of oak (which he calls *needles*, 10 feet long), four by two and an half inches, morticed loosely into the upper lever, and hung thereto by bolts, so as to swing perpendicularly, and play in a long mortice or channel cut through the large lever to receive them. These needles have inch-holes pretty closely bored through them (in a direction crossing the machine), from the lower ends, as far upwards as the great lever will reach, when it is as high as it can go. G, a bed to receive what is to be pressed. H, a frame to support a winch worked by a handle at I. At the end of the small lever two blocks or pulleys are fixed, one above, and the other below it; a rope of about half an inch diameter is then fastened to the ceiling (or continuation of the uprights of the winch frame if necessary) at K; then passed through the upper block on the lever, from thence passed through a block at L, and then goes with four turns round the winch, from whence it is carried through the block under the lever, and fastens to the machine at M; by this means, if the winch be turned one way, it raises the end of the small lever if the other depresses it.

To work the machine. If we suppose the great lever bearing on the matter to be pressed, an iron pin must be put into one of the holes in the needles above the great lever; and when the small lever is worked as far as it will go, either up or down, another bolt is to be put into the hole, which comes nearest above the great lever on the other side of the uprights BB, and the winch then turned the contrary way, by which means the pressing goes on whether the small lever rises or falls. Before the resistance is very great, the needles farthest from the fulcrum of the small lever are used; after that the nearest are employed, which doubles the power of the machine. In raising the great lever, or lowering it to its bearing, the needles most distant from the fulcrum of the small lever, are used *under* instead of *over* it. As the rope is liable to stretch and get slack, he passes it, after taking two turns on the winch, through a pulley, to which is suspended a weight

of half a hundred, and then takes two turns more before it is carried through the other block, by which means the slack is constantly gathered in, and the weight holds on without increasing the friction, as by hanging under the winch it counteracts the pressure upwards on its axis.

The power of this machine is very great, being as 1 to 1136 nearly, and capable by a trifling addition of any other proportion. It is applicable to many purposes beside cyder-pressing, and is more simple, and less liable to injury, than any other which has fallen under our observation. Perhaps, however, it would be an improvement to use, instead of the ropes and pulleys, by which the lever E is moved, a small wheel or pinion of 10 or 12 teeth, on the axis of the winch W (n^o 2.), and a stiff beam *en* down from the lever, having on its lower end an iron rack, of which the teeth take into those of the pinion. The action of these teeth would, in our opinion, be less diminished by friction and obliquity, than the pulleys are by friction and the stiffness of the rope; and the machine would retain all its other advantages.

Press used by Joiners, to keep close the pieces they have glued, especially panels, &c. of wainscot, is very simple, consisting of four members; viz. two screws, and two pieces of wood, four or five inches square, and two or three feet long; whereof the holes at the two ends serve for nuts to the screws.

Press used by Inlayers, resembles the joiner's press, except that the pieces of wood are thicker, and that only one of them is moveable; the other, which is in form of a tressel, being sustained by two legs or pillars, jointed into it at each end. This press serves them for sawing and cleaving the pieces of wood required in marquetry or inlaid work.

Founder's Press, is a strong square frame, consisting of four pieces of wood, firmly joined together with tenons, &c. This press is of various sizes, according to the sizes of the moulds; two of them are required to each mould, at the two extremes whereof they are placed; so as that, by driving wooden wedges between the mould and the sides of the presses, the two parts of the mould wherein the metal is to be run may be pressed close together.

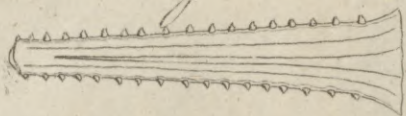
Printing-Press. See *PRINTING-Press*.

Rolling-Press, is a machine used for the taking off prints from copper-plates. It is much less complex than that of the letter-press. See its description and use under the article *Rolling-press* *PRINTING*.

Press, in *Coining*, is one of the machines used in striking of money; differing from the balance, in that it has only one iron bar to give it motion, and presses the moulds or coins; is not charged with lead at its extreme, nor drawn by cordage. See *COINING*.

Binder's Cutting-Press, is a machine used equally by book-binders, stationers, and pasteboard-makers; consisting of two large pieces of wood, in form of cheeks, connected by two strong wooden screws; which, being turned by an iron bar, draw together, or set asunder, the cheeks, as much as is necessary for the putting in the books or paper to be cut. The cheeks are placed lengthwise on a wooden stand, in the form of a chest, into which the cuttings fall. Aside of the cheeks are two pieces of wood, of the same length with the screws, serving to direct the cheeks, and prevent their opening unequally.

Fig. 4.



Pristis.
Fig. 2.

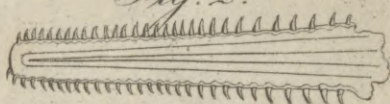


Fig. 1.

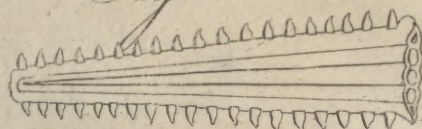


Fig. 3.



Psittacus Pullarius.



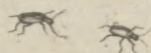
Pulex Monoculus.



Psophia Crepitans.



Plini.



Chego or Pulex Minimus.



Procellaria Peteril.



Psittacus Guineensis.



Press,
Pressing.

unequally. Upon the cheeks the plough moves, to which the cutting-knife is fastened by a screw; which has its key, to dismount it, on occasion, to be sharpened.

The plough consists of several parts; among the rest a wooden screw or worm, which, catching within the nuts of the two feet that sustain it on the cheeks, brings the knife to the book or paper which is fastened in the prefs between two boards. This screw, which is pretty long, has two directories, which resemble those of the screws of the prefs. To make the plough slide square and even on the cheeks, so that the knife may make an equal paring, that foot of the plough where the knife is not fixed, slides in a kind of groove, fastened along one of the cheeks. Lastly, the knife is a piece of steel, six or seven inches long, flat, thin, and sharp, terminating at one end in a point, like that of a sword, and at the other in a square form, which serves to fasten it to the plough. See *Book-Binding*.

As the long knives used by us in the cutting of books or papers, are apt to jump in the cutting thick books, the Dutch are said to use circular knives, with an edge all round; which not only cut more steadily, but last longer without grinding.

Press, in the *Woollen Manufactory*, is a large wooden machine, serving to prefs cloths, serges, rateens, &c. thereby to render them smooth and even, and to give them a gloss.

This machine consists of several members; the principal whereof are the cheeks, the nut, and the worm or screw, accompanied with its bar, which serves to turn it round, and make it descend perpendicularly on the middle of a thick wooden plank, under which the stuffs to be pressed are placed. The *CALENDER* is also a kind of press, serving to prefs or calender linens, silks, &c.

Liberty of the Press. See *LIBERTY of the Press*.

PRESSING, in the manufactures, is the violently squeezing a cloth, stuff, &c. to render it smooth and glossy.

There are two methods of pressing, viz. cold and hot.

As to the former, or cold pressing: After the stuff has been scoured, fulled, and shorn, it is folded square in equal plaits, and a skin of vellum or pasteboard put between each plait. Over the whole is laid a square wooden plank, and so put into the press, which is screwed down tight by means of a lever. After it has lain a sufficient time in the press, they take it out, removing the pasteboards, and lay it up to keep. Some only lay the stuff on a firm table after plaiting and pasteboarding, cover the whole with a wooden plank, and load it with a proper weight.

The method of pressing hot is this: When the stuff has received the above preparations, it is sprinkled a little with water, sometimes gum-water; then plaited equally, and between each two plaits are put leaves of pasteboard; and between every sixth and seventh plait, as well as over the whole, an iron or brass plate well heated in a kind of furnace. This done, it is laid upon the press, and forcibly screwed down. Under this press are laid five, six, &c. pieces at the same time, all furnished with their pasteboards and iron-plates. When the plates are well cooled, the stuffs are taken out and stitched a little together to keep them in the plaits.

This manner of pressing was only invented to cover the defects of the stuffs; and, accordingly, it has been frequently prohibited.

PRESSING, or *Impressing*. See IMPRESSING.

PRESSION, or PRESSURE, in the Cartesian Philosophy, is a supposed impulsive kind of motion, or rather an endeavour to move, impressed on a fluid medium, and propagated through it.

PRESSURE OF AIR. See PNEUMATICS.

PRESSURE of Fluids. See HYDROSTATICS and PNEUMATICS.

PREST, is used for a duty in money, to be paid by the sheriff on his account, in the exchequer, or for money left or remaining in his hands: 2 & 3 Edw. VI. c. 4.

PREST-Money, is so called from the French word *prest*, that is, *promptus, expeditus*; for that it binds those who receive it, to be ready at all times appointed, being commonly meant of soldiers.

PRESTATION-MONEY, is a sum of money paid yearly by archdeacons and other dignitaries to their bishop, *pro exteriori jurisdictione*.

PRESTATION (*prestatio*), was anciently used for other payments: *Et quieti sint de prestatione muragii*. Chart. Hen. VII. Sometimes also for *pourveyance*.

PRESTEIGN is a town in Radnorshire, distant 149 miles west-north-west from London, in the direct road to Aberystwith, and throughout South Wales, in N. Lat. 52° 12', bounded to the north and north-east by Herefordshire. It is a neat well built town, with clean and regular streets, and is the residence of many genteel families. The neighbourhood abounds with all the comforts and conveniences of life. It is seated on a gravelly soil on the banks of the river Lug, and at the head of a very fertile vale: the mountains to the west and north-west of the town forming, as it were, an amphitheatre round it. The name of it in Welsh is *Slan-Andras*, which is supposed to be derived from the church, which is dedicated to Saint Andrew. The town is divided into four wards, which have each a separate jurisdiction, separate officers, levies, &c. The curfew-bell of William the Conqueror still remains in this place, and is rung every night. It is a borough by prescription, and is governed by a bailiff annually elected, and sworn in by a steward appointed by the crown. The living is a rectory and vicarage united, and reported to be worth from L. 500 to L. 600 *per annum*; the parish lying in two counties. Here is an excellent free school well endowed. The county hall, the county gaol, the county bridewell, and house of correction, are kept in this place. The markets are held on Saturdays; and there are two fairs in the year. About a century and a half ago Presteign was considerably larger; had a good woollen manufactory, of which the very large buildings now standing (formerly belonging to clothiers) bear ample testimony; but a fire, succeeded by the plague, in the town about the year 1636, reduced the same, and with it, its consequence as a manufacturing town. The healthiness of its situation cannot be better ascertained than by the register of births and burials. The parish embraces at least a circle of 19 miles; and the average of burials for the last seven years was only 26 persons *per annum*, and that of births for the same time was 42; and of the former upwards of 18 were from 80 to 100 years old.

PRES.

Pressing,
Pressing.

PRESTER (John, or Jean), an appellation formerly given to an emperor of the Tartars who was overcome and killed by Jenghiz Khan. Since that time it has been given to the emperor of Abyssinia or Ethiopia; however, in Ethiopia itself this name is utterly unknown, the emperor being there called the *grand negus*.

PRESTER, a meteor, consisting of an exhalation thrown from the clouds downwards with such violence, as that by the collision it is set on fire. The word is Greek, *πρεστηρ*, the name of a kind of serpent; called also *dipsas*, to which this meteor is supposed to bear a resemblance. The prester differs from the thunderbolt in the manner of its inflammation; and in its burning and breaking every thing it touches with greater violence.

PRESTER, a word used by some to express the external part of the neck, which is usually inflated in anger.

PRESTIMONY, in canon law, is derived a *prestatione quotidiana*; and is, by some, defined to be a kind of benefice, served by a single priest. Others say, it is the incumbency of a chapel, without any title or collation; such as are most of those in castles, where prayers or masses are said; and which are mere unendowed oratories. Whence the term is also applied, in the Romish church, to certain perpetual offices bestowed on canons, religious, or others, for the saying of masses, by way of augmentation of their livings. Others think it is a lease, or concession of any ecclesiastical fund or revenue, belonging to a monastery, to be enjoyed during life. Du Moulin calls it a *profane benefice*, which, however, has a perpetual title, and an ecclesiastical office, with certain revenues attached to it; which the incumbent is allowed to sell, and which may be possessed without tithes; such as the lay church-wardens of Notre-dame. He adds, that, in propriety, the canonries of chapels are benefices of this nature. The most probable opinion seems to be, that prestimony is a fund, or revenue, appropriated by the founder for the subsistence of a priest, without being erected into any title of benefice, chapel, prebend, or priory; and which is not subject either to the pope or to the ordinary, but whereof the patron, and those who have a right from him, are the collators, and nominate and confer *pleno jure*.

PRESTO, in the Italian music, intimates to perform quick; as *prestissimo* does extremely quick.

PRESTON, a town of Lancashire in England, seated on the river Ribble, over which there is a handsome stone bridge. Here is held a court of chancery, and other offices of justice for the county palatine of Lancaster. It is noted for the defeat of the rebels here in 1715, when they were all made prisoners, and sent up to London. W. Long. 2. 26. N. Lat. 53. 45.

PRESTRE. See VAUBAN.

PRETENSED or **PRETENDED** right, in law, is where one is in possession of lands and tenements, which another, who is out, claims and sues for. Here the pretended right is in him who so claims or sues.

PRETERITE, in grammar, a tense which expresses the time past, or an action completely finished; as, *scripsi*, "I have written." See PERFECT and GRAMMAR.

PRETERITION, or **PRETERMISSION**, in rhetoric,

a figure whereby, in pretending to pass over a thing untouched, we make a summary mention thereof. *I do not say he is valiant, he is learned, he is just, &c.* The most artful praises are those given by way of preterition. See ORATORY.

PRETEXT, a colour or motive, whether real or feigned, for doing something.

TOGA PRETEXTA, among the ancient Romans, a long white gown, with a border of purple round the edges, and worn by children of quality till the age of puberty, viz. by the boys till 17, when they changed it for the *toga virilis*; and by the girls till marriage.

PRETIUM SEPULCHRI, in old law books, &c. those goods accruing to the church wherein a corpse is buried. In the Irish canons, lib. xix. cap. 6. it is ordered, that along with every body that is buried, there go his cow, horse, apparel, and the furniture of his bed; none of which may be disposed of otherwise than for the payment of debts, &c. as being familiars and domestics of the deceased.

PRETOR, a magistrate among the ancient Romans, not unlike our lord chief justices, or lord chancellor, or both in one; as being vested with the power of distributing justice among the citizens. At first there was only one pretor; but afterwards, another being created, the first or chief one had the title of *pretor urbanus*, or the "city pretor;" the other was called *peregrinus*, as being judge in all matters relating to foreigners. But, besides these, there were afterwards created many provincial pretors; who were not only judges, but also assisted the consuls in the government of the provinces, and even were invested with the government of provinces themselves.

PRETORIAN GUARDS, in Roman antiquity, were the emperor's guards, who at length were increased to 10,000: they had this denomination, according to some, from their being stationed at a place called *Prætorium*: their commander was styled *præfectus prætorii*.

PRETORIUM, or **PRÆTORIUM**, among the Romans, denoted the hall or court wherein the pretor lived, and wherein he administered justice.

It likewise denoted the tent of the Roman general, wherein councils of war, &c. were held: also a place in Rome where the Pretorian guards were lodged.

PREVARICATION, in the civil law, is where the informer colludes with the defendants, and so makes only a sham prosecution.

PREVARICATION, in our laws, is when a man falsely seems to undertake a thing, with intention that he may destroy it; where a lawyer pleads booty, or acts by collusion, &c.

It also denotes a secret abuse committed in the exercise of a public office, or of a commission given by a private person.

PRIAM, king of Troy, was the son of Laomedon. He was carried into Greece after the taking of that city by Hercules; but was afterwards ransomed, on which he obtained the name of *Priam*, a Greek word signifying "ransomed." At his return he rebuilt Ilium, and extended the bounds of the kingdom of Troy, which became very flourishing under his reign. He married Hecuba, the daughter of Cisseus king of Thrace, by whom he had 19 children; and among the rest Paris, who

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Priam.

Priapismus
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Price.

who carried off Helen, and occasioned the ruin of Troy, which is supposed to have been sacked by the Greeks about 1184 B. C. when Priam was killed by Pyrrhus the son of Achilles at the foot of an altar where he had taken refuge, after a reign of 52 years. See TROY.

PRIAPISMUS, or PRIAPISM, is an erection of the penis without any concomitant pain, or the consent of other parts. It is thus called, because the person in this state resembles the lewd god Priapus. Cælius Aurelianus says it is a palsy of the femal vessels, and other nerves distributed to the parts about the penis, by the distension of which this disorder is produced. It is of the same nature as the satyriasis. See MEDICINE, n° 372.

PRIAPUS, in Pagan worship, the son of Bacchus and Venus, who presided over gardens and the most indecent actions. He was particularly adored at Lampascus, a city at the mouth of the Hellespont, said to be the place of his birth; and his image was placed in gardens to defend them from thieves and birds destructive to fruit. He was usually represented naked, with a stern countenance, matted hair, and holding either a wooden sword or sickle in his hand, and with a monstrous privacy; from whence downward his body ended in a shapeless trunk. The sacrifice offered to this obscene deity was the ass; either on account of the natural uncomeliness of this animal, and its propensity to venery, or from the disappointment which Priapus met with on his attempting the chastity of Vesta, while that goddess was asleep, when she escaped the injury designed her by her being awaked by the braying of old Silenus's ass.

PRICE (Rev. Richard), D. D. L. L. D. fellow of the Royal Society of London, and of the Academy of Sciences, New England, was born at Tynton in Glamorganshire, February 22. 1723. His father was a dissenting minister at Bridgend in that county, and died in 1739. At eight years old he was placed under a Mr Simmons of Neath; and in four years removed to Pentwyn in Caermarthenshire under the Rev. Samuel Jones, whom he represented as a man of a very enlarged mind, and who first inspired him with liberal sentiments of religion. Having lived as long with him as with Mr Simmons, he was sent to Mr Griffith's academy at Talgarth in Breconshire. In 1740 he lost his mother; and on this he quitted the academy and came to London. Here he was settled at that academy, of which Mr Eames was the principal tutor, under the patronage of his uncle the Rev. S. Price, who was co-pastor with Dr Watts upwards of 40 years. At the end of four years he left this academy, and resided with Mr Streatfield of Stoke Newington in the quality of domestic chaplain, while at the same time he regularly assisted Dr Chandler at the Old Jewry, and occasionally assisted others. Having lived with Mr Streatfield near 13 years, on his death and his uncle's he was induced to change his situation, and in 1757 married Miss S. Blundell of Leicestershire. He then settled at Hackney, but being shortly after chosen minister at Newington Green, he lived there until the death of his wife, which was in 1786, when he returned to Hackney. He was next chosen afternoon-preacher at the meeting-house in Poor Jewry-street, but this he resigned on being elected pastor of the Gravel-pit meeting Hackney, and afternoon-preacher at Newington Green. These he resigned with a farewell-sermon in February 1791. Shortly after he was attacked with a nervous

fever, which disappearing was succeeded by a disorder in his bladder, which reduced him to such a degree that, worn out with agony and disease, he died without a groan on the 19th April 1791. He left his property to a sister and two nephews.

Dr Kippis, speaking of his learning and pursuits, observes*, that "his chief aim was to lay a foundation for solid knowledge, by an application to sciences of the noblest kind. It was on the great and fundamental principles and obligations of morality, on the higher species of mathematics, on the sublimer parts of natural philosophy, on the true basis of government, and on the questions which relate to the essential welfare and dignity of man, that his studies were employed; and in the prosecution of these studies he not only enriched his own mind, but was enabled to become of eminent service to his country and to the world. In his moral writings he has laboured with distinguished ability to build the science of ethics on an immutable basis; and what he has advanced will always stand high in estimation as one of the strongest efforts of human reason in favour of the system he has adopted. For myself (adds Dr Kippis), I scruple not to say, that I regard the treatise referred to as a rich treasure of valuable information, and as deserving to be ranked among the first productions of its kind. With respect to his other ethical works, every one must admire the zeal, earnestness, and strength, with which he endeavours to lead men into pious views of God, of providence and prayer; and to promote the exercise of devout and amiable dispositions. In consequence of his profound knowledge in mathematical calculations, he was qualified at a particular crisis for being of singular utility to his fellow-citizens. A number of schemes for insurance for lives, and the benefit of survivorship, promising mighty advantages, were rising up in the metropolis. These ruinous schemes would have been carried to great excess had not Dr Price stepped forward and dispelled the delusion. Gratitude will not allow us to forget the ability and spirit with which he awakened the attention of his countrymen to the reduction of the national debt. With him it was that the scheme of the present minister for that purpose is understood to have originated. What crowned the whole of his character was, its being an assemblage of the most amiable and excellent private virtues. His piety was sincere, humble, and fervent; his soul pure and elevated; in his views disinterested and noble; and in his manners mild and gentle: the applause of his talents and virtues will be transmitted to future ages, and he will be united in the catalogue with the most eminent benefactors of mankind."

This is the panegyric of a friend; but with few abatements it will be admitted by every candid reader. In morals Dr Price's principles were those of Cudworth and Clarke; and by many who have themselves adopted a very different theory, he is allowed to have defended those principles with greater ability than any other writer in the English language (see *MORAL Philosophy*, n° 14.) In metaphysics he was perhaps too great an admirer of Plato, from whom he has borrowed a doctrine concerning ideas which we confess ourselves unable to comprehend. He was a firm believer in the immateriality of the soul; but, with Dr Law, the late learned bishop of Carlisle, he thought, that from death to the resurrection of the body it remains in a dormant or

Price.

* Address
at his Fun-
eral, 8vo.

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quiescent state. He contended for its indivisibility, but maintained at the same time its extension; which furnished Dr Priestley with some advantages in their celebrated controversy, which his own acuteness would never have obtained. In propagating his political principles, which were republican, he sometimes expressed himself with undue vehemence; and he was a zealous enemy to all religious establishments which, in his opinion, encroach upon that liberty wherewith Christ has made us free. His faith respecting the Son of God was what has been called sometimes *low Arianism* and sometimes *Semi-arianism*. From a very early age he claimed the privilege of thinking for himself on every subject. His father was a rigid Calvinist, and spared no pains to instil his own theological dogmas into the tender mind of his son; but young Richard would often start his doubts and difficulties, and sometimes incur the old man's displeasure by arguing against his favourite system with an ingenuity that perplexed, and a solidity that could not be easily overturned. He had once the misfortune to be caught reading a volume of Clarke's sermons, which his father in great wrath snatched from him and threw into the fire. Perhaps he could not have taken a more effectual method to make the book a favourite, or to excite the young man's curiosity after the other works of the same author; and it is by no means improbable that this orthodox bigotry contributed more than any other circumstance to lay the foundation of his son's Arianism.

But whatever may be thought of Dr Price's speculative opinions, whether political or religious, his virtues in private life have never been called in question. Of his practical religion it is impossible to speak in terms too high. There was a fervour even in his public prayers which indicated the strongest sensibility as well as sincerity in himself, and communicated its warmth to those who joined with him. But in his family devotions he gave still fuller scope to the pious emotions of his soul, and proved to those friends who were occasionally present at them how deeply he felt religious impressions, and how happily he blended in this as well as in other things the cool decisions of the understanding with the amiable and exalted sensibilities of the heart.

But it was not in devotion only that these sensibilities were displayed. He was as exemplary in affection to his relatives as in love to his Maker. Of this he gave a striking though private instance before he first quitted his native place to try his fortune in London. His father had left to an elder brother by a former marriage a very considerable fortune; to Richard he left a mere trifle; and to each of two sisters still less. Our author divided his share between his sisters, reserving to himself only a few pounds to defray the expences of his journey, and trusting for his future support to the blessing of God upon his talents and his industry. As in early life he was an affectionate and generous brother, in old age he was a loving and attentive husband. His wife, who for a considerable time before her death was almost wholly helpless, found during the last years of her life hardly any enjoyment except in a game at whist; and though our Doctor disliked cards as a waste of time, and never touched them on any other occasion, to amuse her he would sit down every evening to the card-table, and play till it was late, with

a cheerfulness and good humour which charmed every person who had the happiness of viewing him in that endearing situation.

Yet, though thus attentive to the obligations of domestic life, he did not suffer his private affections to encroach upon his social duties. His talents and his labours were ever ready at the call of friendship; nay, so much did his nature abound with the milk of human kindness, that he could not resist without extreme reluctance even troublesome and unreasonable solicitations. His hours of study and retirement were frequently broken in upon by applications for assistance and advice, especially in matters relating to annuities and life-insurances; and in this way he sacrificed much of his personal convenience to individuals of whom he knew but little, and from whom he would accept of no pecuniary recompense. His good nature in this respect amounted almost to a foible; and subjected him to importunities and loss of time, of which he would sometimes complain as interfering materially with more important and more generally useful studies.

Whilst he thus obliged the rich by his mental talents, he succoured the poor with his earthly substance. A fifth part of his annual income was regularly devoted to charitable purposes; and he was laudably anxious to distribute it in such a way as might produce the greatest good. In the practice of this, and indeed of all his virtues, he was utterly devoid of ostentation. Simplicity and humility were among the strong features of his character. No man was ever less sensible of his own excellence, or less elated by his own celebrity; and in no man was the dignity of artless manners and unaffected modesty more happily displayed.

His face was the true index of his mind. It beamed with philanthropy; and when lighted up in conversation with his friends, assumed an aspect peculiarly pleasing. His person was slender, and rather below the common size, but possessed of great muscular strength and remarkable activity. A habit of deep thought had given a stoop to his figure, and he generally walked a brisk pace with his eyes on the ground, his coat buttoned, one hand in his pocket, and the other swinging by his side.

It is natural to suppose that such a man as Dr Price, some of whose writings were translated into foreign languages, would be very generally respected in the republic of letters, and have many correspondents. The supposition is well founded. In 1763 or 1764 he was chosen a fellow of the Royal Society, and contributed largely to the transactions of that learned body; in 1769 he received from Aberdeen a diploma creating him DD.; and in 1783 the degree of LL.D. was conferred upon him by the college of Yale in Connecticut. As in 1770 he had refused an American degree which had been conveyed to him by Dr Franklin, his acceptance of one 13 years afterwards can be attributed only to his extravagant attachment to a republican form of government; which was the greatest defect in his character, and shows what prejudices the most vigorous mind will imbibe by thinking always on the same subjects, and in the same track. Among his correspondents, the most eminent in his own country were the late Lord Chatham, Lord Stanhope, Lord Lansdowne, the late bishops of Carlisle and St Asaph, and the present bishop of Landaff; Mr Hume, Mr Harris of Salisbury,

Price.

Pride.

lisbury, Dr Gregory of Edinburgh, and the celebrated Mr Howard, who lived with him on terms of the greatest intimacy; in America he corresponded with Dr Franklin, Dr Chauncey, Mr Adams, and others; and in France with the celebrated Turgot, the Duke de Rochefoucault, and several of the first national assembly. One of his female correspondents sketched his character with great justness many years ago under the fictitious but well applied name of *Simplicius*; and with this character we shall close these short memoirs.

“While the vain man is painfully striving to outshine the company and to attract the admiration by false wit, forced compliments, and studied graces, he must surely be mortified to observe how constantly *Simplicius* engages their attention, respect, and complacency, without having once thought of himself as a person of any consequence among them. *Simplicius* imparts his superior knowledge, when called upon, as easily and naturally as he would tell you what it is o'clock; and with the same readiness and good will informs the most ignorant or confers with the most learned. He is as willing to receive information as to give it, and to join the company, as far as he is able, in the most trifling conversation into which they may happen to fall as in the most serious and sublime. If he disputes, it is with as much candour on the most important and interesting as on the most insignificant subjects; and he is not less patient in hearing than in answering his antagonist. If you talk to him of himself or his works, he accepts praise or acknowledges defects with equal meekness, and it is impossible to suspect him of affectation in either. We are more obliged by the plain unexaggerated expressions of his regard, than by the compliments and attentions of the most accomplished pattern of high breeding; because his benevolence and sincerity are so strongly marked in every look, word, and action, that we are convinced his civilities are offered for our sakes, not for his own, and are the natural effects of real kindness, not the studied ornaments of behaviour. Every one is desirous to show him kindness in return, which we know will be accepted just as it is meant. All are ready to pay him that deference which he does not desire, and to give him credit for more than he assumes, or even more than he possesses. With a person ungraceful, and with manners unpolished by the world, his behaviour is always proper, easy, and respectable; as free from constraint and servility in the highest company, as from haughtiness and insolence in the lowest. His dignity arises from his humility; and the sweetness, gentleness, and frankness of his manners, from the real goodness and rectitude of his heart, which lies open to inspection in all the fearlessness of truth, without any need of disguise or ornament.”

Such was Dr Price.—Of his public principles men will think differently; of his private worth there can be but one opinion. He will live in the memory of his friends till memory has lost her power. To posterity his works will be his monument. They are: *A Review of the principal Questions and Difficulties in Morals*, 8vo, 1758; *Dissertations on Providence*, &c. 8vo, 1767; *Observations on Reverfionary Payments*, &c. 8vo, 1771; *Appeal on the National Debt*, &c. 8vo, 1773; *Observations on the Nature of Civil Liberty*, 1776; on *Materialism and Necessity*, in a correspon-

VOL. XV. Part II.

dence between Dr Price and Dr Priestley, 1779; on *Annuities, Assurances, Population*, &c. 8vo, 1779; on the *Population of England*, 1780; on the *Public Debts, Finances, Loans*, &c. 8vo, 1783; on *Reverfionary Payments*, 2 vols, 1783; on the importance of the *American Revolution*, 1784: besides *Sermons*, and a variety of papers in the *Philosophical Transactions* on astronomical and other philosophical subjects.

PRIDE, inordinate and unreasonable self-esteem, attended with insolence and rude treatment of others.—It is frequently confounded with vanity, and sometimes with dignity; but to the former passion it has no resemblance, and in many circumstances it differs from the latter. Vanity is the parent of loquacious boasting; and the person subject to it, if his pretences be admitted, has no inclination to insult the company. The proud man, on the other hand, is naturally silent, and, wrapt up in his own importance, he seldom speaks but to make his audience feel their inferiority. It is this circumstance which distinguishes pride from dignity, and constitutes its sinfulness. Every man possessed of great powers of mind is conscious of them, and feels that he holds a higher rank in the scale of existence than he whose powers are less. If he recollects, at the same time, that he has nothing which he did not receive, and that his superiority is owing to the good pleasure of Him who forms his creatures differently, as the potter forms his clay; he will be so far from insulting his inferiors, that when necessarily in company with them, he will bear with their foibles, and, as far as is proper, make them lose sight of the distance which the laws of God and man have for ever placed between them and him. This condescension, however, if he be a man of dignity, will never lead him to join with them in any mean or dirty action. He will even excuse in them many things which he would condemn in himself, and give them his good wishes, after they have forfeited his esteem. Such a character is amiable and respectable, and what every man should labour to obtain. From the weakness of human nature, however, it is too apt to degenerate into pride.

To a man of great intellectual powers and various erudition, the conversation of ordinary persons affords neither instruction nor amusement; and such conversation, when often repeated, must, from the nature of things, become tedious and irksome. But it requires great command of temper and of manners to prevent uneasiness long felt from sometimes betraying itself by external symptoms, such as peevish expressions, a forbidding look, or absence of mind; and these are the infallible indications of contempt for the company, the very worst ingredient in the passion of pride. If this contempt be often excited, it will be formed into a habit; and the proud man will be so much under its influence, as to insult his inferiors, and sometimes his equals, without forming the resolution to insult either the one or the other. Such a character is hateful to every company, and is so far from indicating true dignity of mind in him to whom it belongs, that it is obviously associated with meanness, and indicates a consciousness of some radical defect. He who possesses real and conspicuous merit has no occasion to depress others for the purpose of raising himself; his superiority will be cheerfully acknowledged: but when a man of undoubted

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eminence in one respect, is so swollen with pride as to make him wish to appear great in all respects, he has no other means of enforcing his ill-founded claim, than displaying his acknowledged superiority, with such insolence as may drive at a distance from him every person by whom he is conscious that in many instances he might be more than rivalled. Whoever is proud of knowledge, would do well to consider how much knowledge he wants.

The same observations which we have made on pride of parts will apply to every other species of pride, such as pride of birth, office, or riches, &c. The peace and order of society require difference of rank, accompanied with different degrees of authority; and he who inherits a title or office from his ancestors, may without pride be conscious of his superiority, provided he forget not that such superiority is conferred on families and individuals, not for their own sakes, but for the good of the community. The peer, who keeps this circumstance in mind, may maintain his station, and repress the forward petulance of the plebeian, without giving offence to any thinking man; but if he dwell upon his rank with too much complacency, he will in process of time be apt to consider himself and his family as superior by nature to those upon whom no title has been conferred, and then his pride will become intolerable. If we could trace our descents, says Seneca, we should find all slaves to come from princes, and all princes from slaves. To be proud of knowledge, is to be blind in the light; to be proud of virtue, is to poison ourselves with the antidote; to be proud of authority, is to make our rise our downfall. The best way to humble a proud man is to neglect him.

PRIDEAUX (Humphry) was born at Padstow in Cornwall in 1648, and was honourably descended by both parents. Three years he studied at Westminster under Dr Busby; and then was removed to Christchurch, Oxford. Here he published, in 1676, his *Marmora Oxoniensia ex Arundelianis, Seldenianis, aliisque conflata, cum perpetuo Commentario*. This introduced him to the lord chancellor Finch, afterward earl of Nottingham, who in 1679 presented him to the rectory of St Clements near Oxford, and in 1681 bestowed on him a prebend of Norwich. Some years after he was engaged in a controversy with the Papists at Norwich, concerning the validity of the orders of the church of England, which produced his book upon that subject. In 1688 he was installed in the archdeaconry of Suffolk; to which he was collated by Dr Lloyd, then bishop of Norwich. In 1691, upon the death of Dr Edward Pococke, the Hebrew professorship at Oxford being vacant, was offered to Dr Prideaux, but he refused it. In 1697, he published his *Life of Mahomet*, and in 1702 was installed dean of Norwich. In 1710 he was cut for the stone, which interrupted his studies for more than a year. Some time after his return to London, he proceeded with his *Connection of the History of the Old and New Testament*; which he had begun when he laid aside the design of writing the *History of Appropriations*. He died in 1724.

PRIENE, an ancient town of Asia Minor. It is now called *Samsun*, and *Samsun-katefi*, which do not however appear to be very recent. It was taken in 1391 by Bajazet, who subdued Ionia. It had formerly, without including the citadel, three gateways; one

of which was towards Kelibesh, an adjoining village; and without it are vaults of sepulchres. The entrance was not wide. A part of the arch, consisting of a single row of massive stones, still remains; but those on which it rests are so corroded by age, broken, or distorted, as to seem every moment ready to yield and let down their load. A rugged way leads to a second opening in the wall opposite to this, and about a mile from it; beyond which are likewise vaults of sepulchres. Between these was a gate facing to the plain; and on the left hand going out of it is a hole, resembling the mouth of an oven, in the side of a square tower; and over it an inscription in small characters, exceedingly difficult to be read. It signifies, that a certain Cyprian in his sleep had beheld Ceres and Proserpine arrayed in white; and that in three visions they had enjoined the worship of a hero, the guardian of the city, and pointed out the place where, in obedience to them, he had erected the god. This was probably some local hero, whose little image was set in the wall, and whose name and memory have perished.

PRIEST, a person set apart for the performance of sacrifice, and other offices and ceremonies of religion. Before the promulgation of the law of Moses, the first-born of every family, the fathers, the princes, and the kings, were priests. Thus Cain and Abel, Noah, Abraham, Melchizedec, Job, Isaac, and Jacob, offered themselves their own sacrifices. Among the Israelites, after their exod from Egypt, the priesthood was confined to one tribe, and it consisted of three orders, the *high-priest*, *priests*, and *Levites*. The priesthood was made hereditary in the family of Aaron, and the first-born of the oldest branch of that family, if he had no legal blemish, was always the high-priest. This divine appointment was observed with considerable accuracy till the Jews fell under the dominion of the Romans, and had their faith corrupted by a false philosophy.—Then, indeed, the high-priesthood was sometimes set up to sale, and instead of continuing for life, as it ought to have done, it seems, from some passages in the New Testament, to have been nothing more than an annual office. There is sufficient reason, however, to believe, that it was never disposed of but to some descendant of Aaron, capable of filling it, had the older branches been extinct. (For the consecration and offices of the Jewish priesthood, we refer our readers to the books of Moses). In the time of David, the inferior priests were divided into 24 companies, who were to serve in rotation, each company by itself, for a week. The order in which the several courses were to serve was determined by lot; and each course was in all succeeding ages called by the name of its original chief.—All nations have had their *priests*. The Pagans had *priests* of Jupiter, Mars, Bacchus, Hercules, Osiris, and Isis, &c.; and some deities had *priestesses*. The Mahometans have priests of different orders, called *schiek*, and *musti*; and the Indians and Chinese have their *bramins* and *bonzes*.

It has been much disputed, whether, in the Christian church, there be any such officer as a *priest*, in the proper sense of the word. The church of Rome, which holds the *propitiatory* sacrifice of the *mass*, has of course her proper *priesthood*. In the church of England, the word *priest* is retained to denote the second order in her hierarchy, but we believe with very different significations, according to the different opinions entertained of the

Lord's

Primæ
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Primer.

Priming
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Primogeniture.

Lord's supper. Some few of her divines, of great learning, and of undoubted Protestantism, maintain that the Lord's supper is a *commemorative* and *eucharistical sacrifice*. These consider all who are authorized to administer that sacrament as in the strictest sense *priests*. Others hold the Lord's supper to be a *feast* upon the *one sacrifice*, once offered on the cross; and these too must consider themselves as clothed with some kind of priesthood. Great numbers, however, of the English clergy, perhaps the majority, agree with the church of Scotland, in maintaining that the Lord's supper is a rite of no other moral import, than the mere commemoration of the death of Christ. These cannot consider themselves as *priests* in the rigid sense of the word, but only as *presbyters*, of which the word *priest* is a contraction of the same import with *elder*. See *SUPPER of the Lord*.

PRIMÆ VIÆ, among physicians, denote the whole alimentary duct; including the œsophagus, stomach, and intestines, with their appendages.

PRIMAGE, in commerce, a small duty at the water-side, usually about 12 d. *per* ton, or 6 d. *per* bale, due to the master and mariners of a ship.

PRIMARY, first in dignity, chief, or principal.

PRIMARY Qualities of Bodies. See METAPHYSICS, n° 152.

PRIMATE, in church-polity, an archbishop, who is invested with a jurisdiction over other bishops.

PRIME, PRIMUS, an appellation given to whatever is first in order, degree, or dignity, among several things of the same or like kind; thus we say, the prime minister, prime cost, &c.

Prime is sometimes used to denote the same with decimal, or the tenth part of an unit.

PRIME-Figure, in geometry, one which cannot be divided into any other figures more simple than itself, as a triangle among planes, and the pyramid among solids.

For prime numbers, in arithmetic, see the article NUMBER.

PRIME of the Moon, is the new moon when she first appears, which is about three days after the change.

PRIME Vertical, is that vertical circle which passes through the poles of the meridian, or the east and west points of the horizon; whence dials projected on the plane of this circle are called *prime vertical*, or *north-and-south dials*.

PRIME, in the Romish church, is the first of the canonical hours, succeeding to lauds.

PRIME, in fencing, is the first of the chief guards. See GUARD.

PRIMER SEASIN, in feudal law, was a feudal burden, only incident to the king's tenants *in capite*, and not to those who held of inferior or mesne lords. It was a right which the king had, when any of his tenants *in capite* died seized of a knight's fee, to receive of the heir (provided he were of full age) one whole year's profits of the lands if they were in immediate possession, and half a year's profits if the lands were in reversion expectant on an estate for life. This seems to be little more than an additional relief, (see RELIEF); but grounded upon this feudal reason, That, by the ancient law of feods, immediately upon the death of a vassal the superior was entitled to enter and

take seisin or possession of the land, by way of protection against intruders, till the heir appeared to claim it, and receive investiture: and for the time the lord so held it, he was entitled to take the profits; and unless the heir claimed within a year and day, it was by the strict law a forfeiture. This practice however seems not to have long obtained in England, if ever, with regard to tenures under inferior lords; but, as to the king's tenures *in capite*, this *prima seifina* was expressly declared, under Hen. III. and Ed. II. to belong to the king by prerogative, in contradistinction to other lords. And the king was entitled to enter and receive the whole profits of the land, till livery was sued; which suit being commonly within a year and day next after the death of the tenant, therefore the king used to take at an average the *first-fruits*, that is to say, one year's profits of the land. And this afterwards gave a handle to the popes, who claimed to be feudal lords of the church, to claim in like manner from every clergyman in England the first year's profits of his benefice, by way of *primitia*, or first-fruits.—All the charges arising by primer seisin were taken away by 12 Car. II. c. 24.

PRIMING, in gunnery, the train of powder that is laid, from the opening of the vent, along the gutter or channel on the upper part of the breech of the gun: which, when fired, conveys the flame to the vent, by which it is further communicated to the charge, in order to fire the piece. This operation is only used on shipboard at the proof, and sometimes in garrison; for, on all other occasions, tubes are used for that purpose.

PRIMING-Wire, in gunnery, a sort of iron needle employed to penetrate the vent or touch-hole of a piece of ordnance, when it is loaded: in order to discover whether the powder contained therein is thoroughly dry and fit for immediate service; as likewise to search the vent and penetrate the cartridge, when the guns are not loaded with the loose powder.

PRIMING, among painters, signifies the laying on of the first colour.

PRIMIPILUS, in antiquity, the centurion of the first cohort of a legion, who had the charge of the Roman eagle.

PRIMITIÆ, the first-fruits gathered of the earth, whereof the ancients made presents to the gods.

PRIMITIVE, in grammar, is a root or original word in a language, in contradistinction to *derivative*; thus, *God* is a primitive; *godly*, a derivative; and *god-like*, a compound.

PRIMOGENITURE, the right of the first-born, has among most nations been very considerable. The first-born son in the patriarchal ages had a superiority over his brethren, and, in the absence of his father, was priest to the family. Among the Jews, he was consecrated to the Lord, had a double portion of the inheritance, and succeeded in the government of the family or kingdom. It is, however, remarkable, and unquestionably shows the connection between this institution and the birth and office of our Saviour, that if a woman's first child was a girl, neither she, nor the children that came after her, were consecrated.

In every nation of Europe, the right of primogeniture prevails in some degree at present, but it did not prevail

Primorie,
Primula.

prevail always. The law which calls the elder-born to the crown, preferably to the others, was not introduced into France till very late; it was unknown to the first race of kings, and even to the second. The four sons of Clovis shared the kingdom equally among themselves; and Louis le Debonnaire did the same: it was not till the race of Hugh Capet, that the prerogative of succession to the crown was appropriated to the first-born.

By the ancient custom of *Gavel-kind*, still preserved in some parts of our island, primogeniture is of no account; the paternal estate being equally shared by all the sons. And it has been a matter of violent and learned dispute, whether, at the death of Alexander III. Balio or Bruce was, by the law as it then stood, heir to the crown of Scotland. The former had undoubtedly the right of primogeniture, but the latter stood in one degree of nearer relation to the deceased sovereign; and the Scottish barons, not being able to determine whose claim was best founded, referred the question to Edward I. of England, and thereby involved their country in a long and ruinous war. See SCOTLAND.

PRIMORIE, is a name given by the Slavi to that tract of sea-coast which lies between the two rivers Cetina and Narenta, the first of which is the Nestus and Tulas, and the second the Narus, of the ancients; comprising what was properly called Dalmatia two ages before our era, and which was known to the Greeks of the low times under the name of *Paratalassia*. Appian informs us, that the Ardei or Vardei possessed many cities there, part of which they seized before the invasion of the Romans, and part they built themselves. We learn also from the *Tabula Peutingeriana*, that after the conquest many of those cities remained, and were inhabited by the conquerors, who also founded new settlements. And indeed were these proofs wanting, the numerous inscriptions found near the sea, and sometimes among the hills, would render it at least probable. The coast is extremely pleasant, the soil fertile, and the situation most convenient for commerce with the inland provinces. By bad management, however, much ground has been lost near the sea, by its being covered with gravel, and by imprudent cultivation of the hills, the impetuous fury of the mountain torrents has rendered a part of it uninhabitable. Macarska is now the only town in the territory, and it appears to have risen out of the ruins of the ancient RATANEUM of Pliny. It formed a part of the Narentan state for several ages, and afterwards, together with the rest of Primorie, passed under the obedience of various Christian princes. It afterwards became subject to the Ottoman Porte, and at last voluntarily subjected itself to the Venetian republic. See DALMATIA and MACARSKA. See also Fortis's *Travels into Dalmatia*, p. 265—318.

PRIMULA, the PRIMROSE: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 21st order, *Precie*. The involucre lies under a simple umbel; the tube of the corolla cylindrical; with the mouth or limb patulous. This genus, including also the polyanthus and auricula, furnishes an excellent collection of low, fibrous-rooted, herbaceous flowery perennials.

1. The *primula veris*, or spring primrose, has thick and very fibrous roots, crowned by a cluster of large

oblong indented rough leaves, and numerous flower-stalks, from about three or four, to five or six inches high; each terminated commonly by one flower.—The varieties are, common yellow-flowered primrose of the woods—white primrose—paper-white—red—double red—double yellow, and double white.—All these flower abundantly in March and April, and continue for a month or six weeks.

The cowslip primrose, or cowslip, has very thick fibrous roots, crowned by a cluster of oblong, indented round leaves, and upright, firm, flower-stalks five or six inches high, terminated each by a cluster of small flowers. The varieties are, Common single yellow cowslip of the meadows—double yellow cowslip—scarlet cowslip—hose-and-hose cowslip; one flower growing out of the bosom of another, the lowermost serving as a calyx; all of which varieties have the flower-stalks crowned by many flowers in branches.—They flower in April and May, continuing in succession a month or six weeks.

2. The polyanthus, has thick fibrous roots, increasing into large bunches, crowned with a cluster of large oblong indented rough leaves; amidst them upright flower-stalks six or eight inches high, terminated mostly by a cluster of several spreading flowers of many different colours in the varieties. The principal are, purple, red, gold, orange-coloured, &c. They all flower beautifully in April and May, and frequently again in autumn; and sometimes even in winter, if the season is mild. The polyanthus is one of the noted prize-flowers among the florists; many of whom are remarkably industrious in raising a considerable variety of different sorts, as well as in using every art to blow them with all requisite perfection; for, among the virtuosi, a polyanthus must possess several peculiar properties in order to be admitted in their collections. The chief properties required in a florist's polyanthus are, 1. The stem or flower-stalk shall be upright, moderately tall, with strength in proportion, and crowned by a good regular bunch of flowers on short pedicles, strong enough to support them nearly in an upright position. 2. The florets of each branch should be equally large, spreading open flat, with the colours exquisite, and the stripes and variegations lively and regular. 3. The eye in the centre of each floret should be large, regular, and bright; and the antheræ, by the florists called the *thrum*, should rise high enough to cover the mouth of the tube or hollow part in the middle of the florets, and render them what they call *thrum-eyed*; but when the style elevates the stigma above the antheræ, the eye of the tube generally appears hollow, showing the stigma in the middle, like the head of a pin, and is rejected as an incomplete flower, though its other properties should be ever so perfect. This pin-eyed polyanthus, however, though rejected by the florists, is the flower in its most perfect state, and great numbers of them are of as beautiful forms and colours as the thrum-eyed varieties.

3. The auricula has a thick fibrous root, crowned by a cluster of oblong, fleshy, broad, serrated, smooth leaves, resembling the shape of a bear's ear; and amidst them upright flower-stalks from about three or four to six or eight inches high, terminated by an umbellate cluster of beautiful flowers, of many different colours

Primula.

Primum,
Prince.

colours in the varieties. All of these have a circular eye in the middle of each flower, and of which there are different colours; whence the auricles are distinguished into yellow-eyed, white-eyed, &c. The petals of most of the kinds are powdered with an exceeding fine farina or mealy powder, which contributes greatly to the beauty of the flower. They all flower in April or May, continuing a month or six weeks in beauty, and ripening plenty of seeds in June.

Culture. All the varieties of the common spring primrose multiply so fast by the roots, that it is scarce worth while to raise them from seeds. However, though many single kinds may be raised from seed, yet parting the roots is the only method by which the double kind can be preserved; and the same thing is to be observed of all the rest.

PRIMUM MOBILE, in the Ptolemaic astronomy, the ninth or highest sphere of the heavens, whose centre is that of the world, and in comparison of which the earth is but a point. This they will have to contain all other spheres within it, and to give motion to them, turning itself, and all them, quite round in 24 hours.

PRINCE, PRINCEPS, in polity, a person invested with the supreme command of a state, independent of any superior.

PRINCE also denotes a person who is a sovereign in his own territories, yet holds of some other as his superior; such are the princes of Germany, who, though absolute in their respective principalities, are bound to the emperor in certain services.

PRINCE also denotes the issue of princes, or those of the royal family. In France, before the revolution, they were called *princes of the blood*, and during the short continuance of the constitution of 1791, *French princes*. In England the king's children are called *sons and daughters of England*; the eldest son is created prince of Wales; the cadets are created dukes or earls as the king pleases; and the title of all the children is *royal highness*: all subjects are to kneel when admitted to kiss their hand, and at table out of the king's presence they are served on the knee. See *Royal Family*.

PRINCE of the Senate, in old Rome, the person who was called over first in the roll of senators, whenever it was renewed by the censors: he was always of consular and censorian dignity. See the article SENATE.

PRINCE'S Metal, a mixture of copper and zinc, in imitation of gold. See CHEMISTRY, n^o 1154.

PRINCETOWN. See *New Jersey*.

Phil. Trans. v. iii. p. 13. &c.
PRINCE of Wales's Island, or Pulo Penang, is situated in the entrance of the straits of Malacca, in 100 degrees of east longitude, and in five degrees of north latitude. It is about seven leagues in length and three in breadth. Its northern extremity runs nearly parallel with the main land at a distance of about two miles, by which a fine channel is formed, where the greatest fleets might ride in perfect safety, the height of the surrounding mountains acting as a barrier against the force of the prevailing winds. The climate, considering its vicinity to the equator, is remarkably mild. Eighty degrees is about the mean height of the thermometer at noon, which, during the night, is seldom above 70. Its healthfulness is certainly not surpassed by that of any European settlement on the coast. Out of a garrison of 300 troops (natives of Hindostan), not one died for the space of 14 months; a singular fact to be experienced

by a new settlement in an uncleared country. This great salubrity is perhaps the effect of a constant ventilation, supported by almost continued but gentle breezes, added to the dryness of the soil, the uniform but gradual elevation from the sea to the foot of the hills preventing those stagnations of water which, in tropical latitudes, are so highly prejudicial to the health of man.

A ridge of beautiful mountains, deeply indented with valleys, and covered with evergreens, divides the island longitudinally. Innumerable rivulets receive their origin from these mountains, and are remarkable for the transparency and coolness of their waters. The soil, which is light and sandy near the sea, gradually changes to a rich clay as it approaches to the high lands. There the sugar-cane grows with the utmost luxuriance, and the most plentiful crops of rice are everywhere produced. The gardens have already furnished the inhabitants with cabbages and potatoes; and when industry shall have reached the tops of the mountains, it will be no surprise to see in the plantations most of the productions of Europe in their utmost perfection. In decorating the landscapes of this little island, nature has been peculiarly lavish. An assemblage of flowering trees and shrubs in perpetual blossom, and endless in the variety of their species, form the first shade. These are overtopped by forest trees of an immense height, which spread their vast branches on every side, and are covered with the richest foliage. Here strangers feel with rapture the effect of the breezes, which, from whatsoever quarter they blow, are strongly impregnated with the fragrance of the groves.

The original animal productions of this island are very limited. Of quadrupeds, the wild hog, deer, and squirrel, nearly comprehend the whole; but the absence of the tiger and leopard, whose numbers and ferocity almost render the opposite shores uninhabitable, amply compensates for this deficiency. The flying fox and squirrel are natives of this island; the former a nondescript, and a great natural curiosity. Of birds there are also but few, and only one which is remarkable for the melody of its notes. The crow and sparrow, the never-failing attendants on population, have but lately made their appearance. They are now, however, rapidly increasing and multiplying. All the domestic animals arrive here at great perfection.

The sea which surrounds the island, affords a vast variety of fish of the most delicious flavour, and its shores abundance of the finest turtle and oysters. In no situation indeed are the conveniences and luxuries of life enjoyed in greater profusion. The advantages of the island in a political and commercial view, are too obvious to require to be pointed out.

PRINCE William's Sound, situated on the north-west coast of America, and so named by Captain Cook in 1778. The men, women, and children of this sound are all clothed in the same manner. Their ordinary dress is a sort of close frock, or rather robe, which sometimes reaches only to the knees, but generally down to the ancles. These frocks are composed of the skins of various animals, and are commonly worn with the hairy side outwards. The men often paint their faces of a black colour, and of a bright red, and sometimes of a bluish or leaden hue; but not in any regu-

Prince,
Principal.

lar figure. The women puncture or stain the chin with black, that comes to a point in each of their cheeks. Their canoes are of two sorts; the one large and open, the other small and covered. The framing consists of slender pieces of wood, and the outside is composed of the skins of seals, or other sea animals, stretched over the wood. Their weapons, and implements for hunting and fishing, are the same as those used by the Greenlanders and Esquimaux. Many of their spears are headed with iron, and their arrows are generally pointed with bone. The food they were seen to eat was the flesh of some animal, either roasted or broiled, and dried fish. Some of the former that was purchased had the appearance of bear's flesh. They also eat a larger sort of fern-root, either baked or dressed in some other method. Their drink, in all probability, is water; for, in their canoes, they brought snow in wooden vessels, which they swallowed by mouthfuls. Our knowledge of the animals of this part of the American continent is entirely derived from the skins that were brought by the natives for sale. These were principally of bears, common and pine martins, sea-otters, seals, racoons, small ermines, foxes, and the whitish cat or lynx. The birds found here were the halcyon, or great king's-fisher, which had fine bright colours; the white-headed eagle, and the humming-bird. The fish that were principally brought to market for sale were torok and halibut. The rocks were almost destitute of shell-fish; and the only other animal of this tribe that was observed was a reddish crab, covered with very large spines. Few vegetables of any kind were observed; and the trees that chiefly grew about this found were the Canadian spruce pine, some of which were of a considerable size. E. Long. 115. 21. N. Lat. 59. 33.

PRINCIPAL, the chief and most necessary part of a thing. The principal of a college or hall is the master thereof.

In commerce, principal is the capital of a sum due or lent; so called in opposition to interest. See INTEREST.

It also denotes the first fund put by partners into a common stock, by which it is distinguished from the calls or accessions afterwards required.

PRINCIPAL, in music. See FUNDAMENTAL, in music, and GENERATOR, in music.

PRINCIPAL, in law, is either the actor or absolute perpetrator of the crime, who is called a *principal*, in the first degree; or he who is present, aiding and abetting the fact to be done, who is denominated a *principal* in the second degree. The presence of a principal need not always be an actual immediate standing by, within sight or hearing of the fact; but there may be also a constructive presence, as when one commits a robbery or murder, and another keeps watch or guard at some convenient distance. And this rule has also other exceptions; for, in case of murder by poisoning, a man may be a principal felon by preparing and laying the poison, or giving it to another (who is ignorant of its poisonous quality) for that purpose; and yet not administer it himself, nor be present when the very deed of poisoning is committed. And the same reasoning will hold, with regard to other murders committed in the absence of the murderer, by means which he had prepared before-hand, and which probably could

not fail of their mischievous effect. As by laying a trap or pit-fall for another, whereby he is killed; letting out a wild beast, with an intent to do mischief; or exciting a madman to commit murder, so that death thereupon ensues: in every one of these cases the party offending is guilty of murder as a principal, in the first degree. For he cannot be called an accessory, that necessarily pre-supposing a principal; and the poison, the pit-fall, the beast, or the madman, cannot be held principals, being only the instruments of death. As therefore he must be certainly guilty, either as principal or accessory, and cannot be so as accessory, it follows that he must be guilty as principal; and if principal, then in the first degree; for there is no other criminal, much less a superior in the guilt, whom he could aid, abet, or assist.

PRINCIPAL Point, in perspective, is a point in the perspective plane, upon which a line is drawn from the eye, perpendicular to the plane falls.

This point is in the intersection of the horizontal and vertical plane; and is also called the *point of sight*, and *point of the eye*. See PERSPECTIVE.

PRINCIPAL Ray, in perspective, is that which passes perpendicularly from the spectator's eye to the perspective plane, or picture.

Whence the point where this ray falls on the plane, is by some also called the *principal point*, which other writers call the *centre of the picture*, and the *point of concurrence*.

PRINCIPATO, the name of a province of Italy, in the kingdom of Naples, which is divided into two parts, called by the Italians the *Principato Ultra* and the *Principato Citra*, that is, the Hither and Farther Principato. The Hither Principato is bounded on the north by the Farther Principato and part of the Terra-di-Lavoro, on the west and south by the Tuscan Sea, and on the east by the Basilicata. It is about 60 miles in length, and 30 in breadth; the soil is fertile in wine, corn, oil, and saffron; and they have a great deal of silk, besides several mineral springs. The capital town is Salerno. The Farther Principato is bounded on the north by the county of Molese and the Terra-di-Lavoro, on the west by the Tuscan Sea, on the south by the Hither Principato, and on the east by the Capitanata. It is about 37 miles in length, and 30 in breadth. The Apennine mountains render the air cold; and the soil is not very fertile either in corn or wine, but it produces chestnuts, and pastures in great plenty. Benevento is the capital town.

PRINCIPLE, PRINCIPIUM, in general, is used for the cause, source, or origin of any thing.

PRINCIPLE, in human nature. See DISPOSITION.

PRINCIPLE, in science, is a truth, admitted without proof, from which other truths are inferred by a chain of reasoning. Principles are of two kinds, *primary* and *general*; and to the last the name of *axioms* is usually given on account of their importance and *dignity*. An axiom or *general* principle, when the terms in which it is expressed are understood, must be a self-evident truth; but from its very nature it cannot be a *first* truth. Our first truths are all *particular*. A child knows that two *particular* lines, each an inch long, are equal to one another, before he has formed any *general* notions of length and equality. "Things equal to one and the same thing are equal to one another," is the

Principal
||
Principle.

Blackst.
Comment.
b. iv. c. 3.

Principle
Pringle.

first of Euclid's axioms; and an axiom it undoubtedly is, but to no man has it been a *first* truth. It is, if we may use the expression, a *genus* or *class* of truths comprehending under it numberless individuals. Were a full-grown man introduced into the world, without a single idea in his mind, as we may suppose Adam to have been, he would instantly perceive, upon laying together three pieces of wood each a foot long, that they were all equal in length; and if he were to cut another to the same length with *any one* of them, he would find upon trial, that it was of the same length with them all. After a few simple experiments of this kind, he would, by a law of human thought, infer that all things equal in length or in any other dimension, to any *one* thing, are in that dimension equal to one another.

It was not therefore with such weakness as some have imagined, that Hobbes affirmed those propositions commonly called axioms, not to be primary but secondary principles. A primary principle deserves not the name of an axiom, as it is only a particular truth including in it no other truth. There is not one of Euclid's axioms which has not been the result of induction, though we remember not the time at which the induction was made. That the whole is greater than any of its parts is a general truth which no man of common sense can controvert; but every one discovered that truth by observing that his body was larger than his head, his foot, or his hand; that a mountain is larger than a mole-hill in the middle of it; and that a piece of timber measuring what is called a yard is longer than any one of the divisions marked upon it, and termed inches. The particular observations are made through the senses and treasured up in the memory; and the intellect, by its constitution, compares them together, marks in what they agree and disagree, and thence draws its *axioms* or *general* principles. He, therefore, who should admit the truth of an axiom, and deny the evidence of sense and perception, would act as absurdly as he who accepts payment in a bank-bill, and refuses it in the individual pieces of gold or silver which that bill represents. General axioms are of infinite use in the pursuits of science; but it is not because they create new truths; they only shorten the process in the discovery of such as might be found, with labour, through the medium of particular propositions. See *Campbell's Philosophy of Rhetoric* and *Tatham's Chart and Scale of Truth*.

PRINCIPLES, in physics, are often confounded with elements, or the first and simplest parts whereof natural bodies are compounded, and into which they are again resolvable by the force of fire.

PRINGLE (Sir John), an eminent physician and philosopher, was a younger son of Sir John Pringle of Stitchel, in the shire of Roxburgh, Baronet; took the degree of M. D. at Leyden, 1730; and published there *Dissertatio Inauguralis de Marcore Senili*, 4to. After having been some years professor of moral philosophy at Edinburgh, he was in June 1745 appointed physician to the duke of Cumberland, and physician-general to the hospital of the forces in Flanders, where the earl of Stair appears to have been his patron. In February 1746, Dr Pringle, Dr Armstrong, and Dr Barker, were nominated physicians to the hospital for lame, maimed, and sick soldiers, behind Buckingham-

house; and in April 1749, Dr Pringle was appointed physician in ordinary to the king. In 1750 he published "Observations on the Nature and Cure of Hospital and Gaol Fevers, in a Letter to Dr Mead," 8vo (reprinted in 1755); and in 1752 he favoured the public with the result of his long experience in an admirable treatise under the title of "Observations on the Disorders of the Army in Camp and Garrison," 8vo. On the 14th of April 1752, he married Charlotte, second daughter of Dr Oliver, an eminent physician at Bath. In 1756 he was appointed jointly with Dr Wintringham (now Sir Clifton Wintringham, Bart.) physician to the hospital for the service of the forces of Great Britain. After the accession of his present majesty, Dr Pringle was appointed physician to the queen's household, 1761; physician in ordinary to the queen in 1763, in which year he was admitted of the college of physicians in London; and on the 5th of June 1766, he was advanced to the dignity of a baronet of Great Britain. In 1772 he was elected president of the Royal Society, where his speeches for five successive years, on delivering the prize-medal of Sir Godfrey Copley, gave the greatest satisfaction. Sir John Pringle in 1777 was appointed physician-extraordinary to the king. He was also a fellow of the College of Physicians at Edinburgh, and of the Royal Medical Society at Paris; member of the Royal Academies at Paris, Stockholm, Gottingen, and of the Philosophical Societies at Edinburgh and Haerlem; and continued president of the Royal Society till November 1778; after which period he gradually withdrew from the world, and in 1781 quitted his elegant house in Pall Mall (where he had long distinguished himself as the warm friend and patron of literary men of every nation and profession), and made an excursion to his native country. He returned to London in the latter end of that year; died greatly beloved and respected January 18. 1782; and having no children, was succeeded in estate, and also (agreeably to the limitation of the patent) in title, by his nephew, now Sir James Pringle, Bart. Among this worthy physician's communications to the Royal Society, the following are the principal: 1. "Some Experiments on Substances resisting Putrefaction," Phil. Trans. N^o 495, p. 580; and N^o 496, p. 525, 550; reprinted, with additions, in Martin's Abridgment, vol. xi. p. 1365. 2. "Account of some Persons seized with the Gaol Fever by working in Newgate, and of the manner by which the Infection was communicated to one entire Family," vol. xlviii. p. 42. At the request of Dr Hales, a copy of this useful paper was inserted in the Gentleman's Magazine, 1753, p. 71, before its appearance in the Transactions. 3. "A remarkable Case of Fragility, Flexibility, and Dissolution of the Bones," ib. p. 297. 4. "Account of the Earthquakes felt at Brussels," vol. xlix. p. 546. 5. "Account of sinking of a River near Pontypool, in Monmouthshire," ib. p. 517. 6. "Account of an Earthquake felt Feb. 18. 1756, along the coast of England, between Margate and Dover," ib. p. 579. 7. "Account of the Earthquake felt at Glasgow and Dumbarton; also of a Shower of Dust falling on a Ship between Shetland and Iceland," ib. p. 509. 8. "Several Accounts of the Fiery Meteor which appeared on Sunday, November 26. 1758, between eight and nine at night," vol. l. p. 218. 9. "Account of the Virtues

Pringle.

Prinos
ll
Printing.

tues of Soap in dissolving the Stone, in the Case of the Reverend Mr Matthew Simson," ib. p. 221. 10. "Account of the Effects of Electricity in Paralytic Cases," ib. p. 481. And see a letter to him on that subject from Professor Winthorp. "Some Account of the Success of the *Vitrum Ceratum Antimonii*," was printed in the Edinburgh Medical Essays, vol. v.

PRINOS, in botany: A genus of the monogynia order, belonging to the hexandria class of plants; and in the natural method ranking under the 43d order, *Dumose*. The calyx is sexfid; the corolla monopetalous, and rotaceous; the belly hexaspermous.

PRINTER, a person who composes and takes impressions from moveable characters ranged in order, by means of ink, and a press.

PRINTING, the art of taking impressions from characters or figures, moveable and immovable, on paper, linen, silk, &c. There are three kinds of printing: the one from moveable letters, for books; another from copper-plates, for pictures; and the last from blocks, in which the representation of birds, flowers, &c. are cut, for printing calicoes, linen, &c. The first is called *common* or *letter-press* printing; the second, *rolling-press* printing; and the last, *calico*, &c. printing. The principal difference between the three consists in this, that the first is cast in relieve, in distinct pieces; the second engraven in creux; and the third cut in relieve, and generally stamped, by placing the block upon the materials to be printed, and striking upon the back of it.

1
Letter-
press print-
ing.

Of the above branches, LETTER-PRESS PRINTING is the most curious, and deserves the most particular notice: for to it are owing chiefly our deliverance from ignorance and error, the progress of learning, the revival of the sciences, and numberless improvements in arts, which, without this noble invention, would have been either lost to mankind, or confined to the knowledge of a few. "To the art of printing (says an elegant essayist*), it is acknowledged we owe the reformation. It has been justly remarked, that if the books of Luther had been multiplied only by the slow process of the hand-writing, they must have been few, and would have been easily suppressed by the combination of wealth and power: but, poured forth in abundance from the press, they spread over the land with the rapidity of an inundation, which acquires additional force from the efforts used to obstruct its progress. He who undertook to prevent the dispersion of the books once issued from the press, attempted a task no less arduous than the destruction of the hydra. Resistance was vain, and religion was reformed: and we who are chiefly interested in this happy revolution must remember, amidst the praises bestowed on Luther, that his endeavours had been ineffectual, unassisted by the invention of Faustus.

3
Good and
evil result-
ing from it.

"How greatly the cause of religion has been promoted by the art, must appear, when it is considered, that it has placed those sacred books in the hand of every individual, which, besides that they were once locked up in a dead language, could not be procured without great difficulty. The numerous comments on them of every kind, which tend to promote piety, and to form the Christian philosopher, would probably never have been composed, and certainly would not have extend-

ed their beneficial influence, if typography had still been unknown. By that art, the light, which is to illuminate a dark world, has been placed in a situation more advantageous to the emission of its rays: but if it has been the means of illustrating the doctrines, and enforcing the practice of religion, it has also, particularly in the present age, struck at the root of piety and moral virtue, by propagating opinions favourable to the sceptic and the voluptuary. It has enabled modern authors wantonly to gratify their avarice, their vanity, and their misanthropy, in disseminating novel systems subversive of the dignity and happiness of human nature: but though the perversion of the art is lamentably remarkable in those volumes which issue, with offensive profusion, from the vain, the wicked, and the hungry, yet this good results from the evil, that as truth is great and will prevail, she must derive fresh lustre, by displaying the superiority of her strength in the conflict with sophistry.

"Thus the art of printing, in whatever light it is viewed, has deserved respect and attention. From the ingenuity of the contrivance, it has ever excited mechanical curiosity; from its intimate connection with learning, it has justly claimed historical notice; and from its extensive influence on morality, politics, and religion, it is now become a subject of very important speculation.

"But however we may felicitate mankind on the invention, there are perhaps those who wish, that, together with its compatriot art of manufacturing gunpowder, it had not yet been brought to light. Of its effects on literature, they assert, that it has increased the number of books, till they distract rather than improve the mind; and of its malignant influence on morals, they complain, that it has often introduced a false refinement, incompatible with the simplicity of primitive piety and genuine virtue. With respect to its literary ill consequences, it may be said, that though it produces to the world an infinite number of worthless publications, yet true wit and fine composition will still retain their value, and it will be an easy task for critical discernment to select these from the surrounding mass of absurdity: and though, with respect to its moral effects, a regard to truth extorts the confession, that it has diffused immorality and irreligion, divulged with cruel impertinence the secrets of private life, and spread the tale of scandal through an empire; yet these are evils which will either shrink away unobserved in the triumphs of time and truth over falsehood, or which may, at any time, be suppressed by legislative interposition."

4
Its good
effects
overbalance
the bad.

Some writers have ascribed the origin of this art to the East, and affixed a very early period to its invention; particularly P. Jovius, (*Hist. lib. xiv. p. 226. ed. Florent. 1550*), from whom Oforius and many others have embraced the same opinion. But these have evidently confounded the European mode of printing with the *engraved tablets* which to this day are used in China. The invention of these tablets has been ascribed by many writers even to an earlier period than the commencement of the Christian era; but is with more probability assigned, by the very accurate Phil. Complet, to the year 930. The *Historia Sinenfis* of Abdalla, written in Persic in 1317, speaks of it as an art in very common use. MEERMAN, vol. i. p. 16. 218, 219, vol. ii. p. 186. N. Trigault asserts that the Chinese practised the art of printing

5
History of
the inven-
tion of
printing.

Printing. printing five centuries before. Count Ferre Rezzonico found at Lyons plates with words and names engraven by a Nuremberger 1380.

The honour of having given rise to the European method has been claimed by the cities of *Harlem*, *Mentz*, and *Straßburg*. And to each of these it may be ascribed in a qualified sense, as they made improvements upon one another.

6
Claim of
Harlem.

I. The first testimony of the inventor is that recorded by Hadrian Junius, in his *Batavia*, p. 253, ed. Lugd. Bat. 1588; which, though it hath been rejected by many, is of undoubted authority. Junius had the relation from two reputable men; Nicolaus Galius (A), who was his schoolmaster; and Quirinius Tafesius, his intimate and correspondent. He ascribes it to LAURENTIUS, the son of John (Ædituus, or Custos, of the cathedral at HARLEM, at that time a respectable office), upon the testimony of Cornelius, some time a servant to Laurentius, and afterwards bookbinder to the cathedral, an office which had before been performed by Franciscan friars. His narrative was thus: "That, walking in a wood near the city (as the citizens of opulence use to do), he began at first to cut some letters upon the rind of a beech-tree; which, for fancy's sake, being impressed on paper, he printed one or two lines, as a specimen for his grand-children (the sons of his daughter) to follow. This having happily succeeded, he meditated greater things (as he was a man of ingenuity and judgment); and first of all, with his son-in-law Thomas Peter (who, by the way, left three sons, who all attained the consular dignity), invented a more glutinous writing-ink, because he found the common ink sunk and spread; and then formed whole pages of wood, with letters cut upon them; of which sort I have seen some essays, in an anonymous work, printed only on one side, intitled, *Speculum nostra salutis*; in which it is remarkable, that in the infancy of printing (as nothing is complete at its first invention) the back sides of the pages were pasted together, that they might not by their nakedness betray their deformity. These beechen letters he afterwards changed for leaden ones, and these again for a mixture of tin and lead [*stanneus*] as a less flexible and more solid and durable substance. Of the remains of which types, when they were turned to waste metal, those old wine-pots were cast, that are still preserved in the family-house, which looks into the market-place, inhabited afterwards by his great-grandson Gerard Thomas, a gentleman of reputation; whom I mention for the honour of the family, and who died old a few years since. A new invention never fails to engage curiosity. And when a commodity never before seen excited purchasers, to the advantage of the inventor, the admiration of the art increased, dependents were enlarged, and workmen multiplied;

Vol. XV. Part II.

Printing. the first calamitous incident! Among these was one John, whether, as we suspect, he had ominously the name of *Fauslus* (B), unfaithful and unlucky to his master, or whether it was really a person of that name, I shall not much inquire; being unwilling to molest the silent shades, who suffer from a consciousness of their past actions in this life. This man, bound by oath to keep the secret of printing, when he thought he had learned the art of joining the letters, the method of casting the types, and other things of that nature, taking the most convenient time that was possible, on Christmas eve, when every one was customarily employed in lustral sacrifices, seizes the collection of types, and all the implements his master had got together, and, with one accomplice, marches off to Amsterdam, thence to Cologne, and at last settled at Mentz, as at an asylum of security, where he might go to work with the tools he had stolen. It is certain, that in a year's time, viz. in 1442, the *Doctrinale* of Alexander Galius, which was a grammar much used at that time, together with the *Tracts* of Peter of Spain, came forth there, from the same types as Laurentius had made use of at Harlem."

Thus far the narrative of Junius, which he had frequently heard from Nicolaus Galius; to whom it was related by Cornelius himself, who lived to a great age, and used to burst into tears upon reflecting on the loss his master had sustained, not only in his substance, but in his honour, by the roguery of his servant, his former associate and bedfellow. Cornelius, as appears by the registers of Harlem cathedral, died either in 1515, or the beginning of the following year; so that he might very well give this information to Nicolaus Galius, who was schoolmaster to Hadrian Junius.

Though this circumstance is probable as to the main fact, yet we must set aside the evidence of it in some particulars. 1. The first obvious difficulty is noticed by Scrivener; "that the types are said to be made of the rind of beech, which could not be strong enough to bear the impression of the press:" though this is removed, if, instead of the *bark*, we substitute a *bough* of the beech. The idea of the *bark*, when Junius wrote this, was perhaps strong in his mind, from what Virgil tells us (Ecl. v. 13.) of its being usual to cut words on the bark of a beech; and thence he was easily led to make a wrong application of it here.

Bower and
Nichols's
Origin of
Printing.

2. The letters were at first *wooden*, and are said to be afterwards exchanged for *metal* types; from which the wine-pots were formed, remaining in the time of Junius. According to tradition, printing was carried on in the same house long after the time of Laurentius: these pots might therefore be formed from the waste metal of the printing-house, after the use of *fusile* types became universal. — But Laurentius seems to have carried the art no farther than *separate wooden types*. What is a

3 T

remarkable

(A) Galius seems to be the same who is called *Claes Lottynsz. Gael*, Scabinus Harleми, as it is in the Fasti of that city, in the years 1531, 1533, and 1535. Quirinius in the same Fasti is called *Mr Quiryn Dinkszoon*. He was many years amanuensis to the great Erasmus, as appears from his epistle, 23d July 1529. tom. iii. Oper. p. 1222. He was afterwards Scabinus in 1537 & seq. and Consul in 1552 & seq. But in the troubles of Holland he was cruelly killed by the Spanish soldiers, May 23. 1573. There are some letters of Hadrian Junius to this Tafesius, in the *Epistola Juniana*, p. 198.

(B) *John Faust*, or *Fust*, is by many supposed to have derived his name from *faustus*, "happy;" and Dr Faustus seems to carry an air of grandeur in the appellation: but very erroneously. *John Faust*, or *Fust*, is no more than *John Hand*, whence our name *Fist*.

Printing. remarkable confirmation of this, Henry Spiechel, who wrote, in the 16th century, a Dutch poem intitled *Hertspiegel*, expresses himself thus: "Thou first, Laurentius, to supply the defect of wooden tablets, adaptedst wooden types, and afterwards didst connect them with a thread, to imitate writing. A treacherous servant surreptitiously obtained the honour of the discovery. But truth itself, though destitute of common and wide-spread fame; truth, I say, still remains." No mention in the poem of *metal types*; a circumstance which, had he been robbed of such, as well as of *wooden* ones, would scarcely have been passed over in silence.

When Laurentius first devised his rough specimen of the art, can only be guessed at. He died in 1440, after having published the *Speculum Belgicum*, and two editions of *Donatus*, all with different *wooden types*; which it is probable (considering the difficulties he had to encounter, and the many artists whom he must necessarily have had occasion to consult) cost him some years to execute; so that the first essay might be about 1430, which nearly agrees with Petrus Scriverius, who says the invention was about 10 or 12 years before 1440. See LAURENTIUS.

3. What was the specimen he first diverted himself with in cutting, at the distance of three centuries, one would think impossible to be discovered. And yet Joh. Enschedius, a printer, thinks he was so happy as to find it, being an old parchment *Horarium*, printed on both sides, in eight pages, containing the Letters of the Alphabet, the Lord's Prayer, the Apostles Creed, and three short prayers. And Mr Meerman having

Printing. shown this to proper artists who were judges of these matters, they gave it as their opinion that it agreed exactly with the description of Junius. It is conformable to the first edition of the Dutch *Speculum Salvationis*, and the fragments of both *Donatus's* of Holland, both which are the works of the same Laurentius, and were preceded by this. In these types, which are certainly moveable, cut, and uneven, there is a rudeness which Mr Meerman has not observed in any other instances. There are no numbers to the pages, no signatures, no *direction-words*, no divisions at the end of the lines; on the contrary, a syllable divided in the middle is seen, thus, *Sp iritu*, in p. 8. l. 2, 3. There are neither distinctions nor points, which are seen in the other works of Laurentius; and the letter *i* is not marked with an accent, but with a dot at the top. The lines throughout are uneven. The shape of the pages not always the same; not (as they should be) rectangular, but sometimes rhomb-like, sometimes an *isoscele trapezium*; and the performance seems to be left as a specimen both of his piety, and of his ingenuity in this essay of a new invented art. Mr Meerman has given an exact engraving of this singular curiosity.

But, whatever else may appear doubtful in the narrative of Junius, it is very clear, that the first essays of the art are to be attributed to Laurentius, who used only *separate wooden types*. See the article LAURENTIUS.

II. Some of Laurentius's types were stolen from him by one of his servants (c), John GEINSFLEICH senior; who fled therewith to MENTZ. Having introduced the

7
Claim of
Mentz.

(c) Authors differ as to the person who committed this robbery. It is clear from all accounts that his name was *John*; but what his surname was is the disputed point. Junius, after some hesitation, ascribes it to John Fust; but with injustice: for he was a wealthy man, who assisted the first printers at Mentz with money; and though he afterwards was proprietor of a printing-office, yet he never, as far as appears, performed any part of the business with his own hands, and consequently he could never have been a servant to Laurentius. Nor is the conjecture of Scriverius better founded, which fixes it upon John Gutenberg, who (as appears by authentic testimonies) resided at Strasburg from 1436 to 1444, and during all that period employed much fruitless labour and expence in endeavouring to attain this art. Mr Meerman once thought, "it might be either John Meidenbachius, (who, we are told by Seb. Munster and the author of *Chronographia Moguntinensis*, was an assistant to the first Mentz printers); or John Peterheimius (who was some time a servant to Fust and Schoeffer, and set up a printing-house at Francfort in 1459): or, lastly, some other person, who, being unable through poverty to carry on the business, discovered it to *Geinsfleisch* at Mentz." But more authentic intelligence afterwards convinced him there were two persons of this name; and that John Geinsfleisch senior* was the dishonest servant, who was born at Mentz, and who in the papers published by Kohlerus, we find there in the year 1441, and not before: for though he was of a good family, yet he was poor, and seems to have been obliged, as well as his brother, to seek his livelihood in a foreign country; and perhaps was content to be under Laurentius, that, when he had learned the art, he might follow it in his own. But, to leave conjecture, we may produce some certain testimonies.

1. It is what Junius himself says, that the person who stole the types did it with a view to set up elsewhere; nor is it likely that he would either make no use of an art he had seen so profitable to Laurentius, or that he would teach it to another and submit to be again a servant.

2. The Lambeth Record (which is printed below, from Mr Atkyns) tells us, that "Mentz gained the art by the brother of one of the workmen of Harlem, who learned it at home of his brother, who after set up for himself at Mentz."—By the strictest examination of the best authorities, it is plain, that by these *two brothers* the two *Geinsfleiches* must be meant. But as the younger (*Gutenberg*) was never a servant to Laurentius, it must be the senior who carried off the types, and instructed his brother in the art; who first applied himself to the business at Strasburg, and afterwards joined his elder brother, who had in the mean time settled at Mentz.

* He was called *Geinsfleisch* κατ' ἔξωτον; the other was distinguished by the name of *Gutenberg*. They were both poor; though of a family distinguished by knighthood. They were both married men; and were most probably brothers, as it was not uncommon in that age for two brothers to have the same Christian name. These both appear in a respectable light. The eldest robbed his master, with many aggravating circumstances. The youngest was remarkably contentious; and, after entering into a contract of marriage with Anna, a noble girl of *The Iron Gate*, refused to marry her till compelled by a judicial decree; and afterwards cared not what became of the lady, but left her behind at Strasburg when he removed to Mentz. He had not only frequent quarrels with his wife; but with *Andrew Drizzen*, *Andrew Heilmann*, and *John Riff*, all of whom were associated with him at Strasburg in his different employments of making of looking glasses, polishing of precious stones, and endeavouring to attain the art of printing; and with these he involved himself in three law-suits. See *Meerman*, vol. i. p. 103, &c. N.

Printing. the art from Harlem into this his native city, he set with all diligence to carry it on; and published, in 1442, *ALEXANDRI GALLI Doctrinale*, and *PETRI HISPANI Tractatus*; two works, which, being small, best suited his circumstances; and for which, being much used in the schools, he might reasonably expect a profitable sale. They were executed with *wooden types*, cut after the model of those he had stolen.

In 1443 he hired the house Zum Jungen; and was assisted with money by FUST, a wealthy person, who in return had a share of the business: and about the same time *John Meidenbachius* was admitted a partner, as were some others whose names are not transmitted to our times; and in 1444 they were joined by GUTENBERG, who for that purpose quitted Strasburg. *Wooden types* being found not sufficiently durable, and not answering expectation in other respects, the two brothers first invented *cut metal types*. But while these were preparing, which must have been a work of time, several works were printed, both on *wooden separate types* and on *wooden blocks*; which were well adapted to small books of frequent use, such as the *Tabula Alphabctica*, the *Catholicon*, *Donati Grammatica*, and the *Concessionaria*.

From the above-mentioned printers in conjunction, after many smaller essays, the Bible was published in 1450, with *large cut metal types* (D). And it is no wonder, considering the immense labour this work cost, that it should be seven or eight years in completing. In this same year the partnership was dissolved, and a new one entered into, in August, between *Fust and Gutenberg*;

the former supplying the money, the latter skill, for their common benefit. Various difficulties arising, occasioned a law-suit for the money which Fust had advanced; which was determined against Gutenberg. A dissolution of this partnership ensued in 1455; and in 1457 a magnificent edition of the Psalter was published by *Fust and Schoeffer*, with a remarkable commendation, in which they assumed to themselves the merit of a new invention, (viz of *metal types*), *ad inventionem artificiosam imprimendi ac characterizandi*. This book was uncommonly elegant, and in some measure the work of Gutenberg; as it was four years in the press, and came out but 18 months after the partnership was dissolved between him and Fust.

The latter continued in possession of the printing-office: and *Gutenberg*, by the pecuniary assistance of Courad Humery syndic of Mentz (E), and others, opened another office in the same city; whence appeared, in 1460, without the printer's name, the *Catholicon Jo. de Janua*, with a pompous colophon in praise of its beauty, and ascribing the honour of the invention to the city of Mentz. It was a very handsome book, though inferior to the Psalter which had been published in 1457 by Fust and Schoeffer. Both the Psalter and *Catholicon* were printed on *cut metal types* (F). It may not be improper to observe here, that as the Psalter is the earliest book which is known to have a genuine date, it became a common practice, after that publication, for printers to claim their own performances, by adding their names to them.

III. The progress of the art has been thus traced
3 T 2 through

What is still stronger, two chronologers of Strasburg, the one named *Dan Speklinus*, the other anonymous (in Meerman's *Documenta*, n° LXXXV. LXXXVI.), tells us expressly, that John Geinsfleisch (viz. the senior, whom they distinguished from Gutenberg), having learned the art by being servant to its *first inventor*, carried it by theft into Mentz his native country. They are right in the fact, though mistaken in the application of it; for they make Strasburg the place of the invention, and Mentelius the inventor, from whom the types were stolen. But this is plainly an error: for Geinsfleisch lived at Mentz in 1441, as appears from undoubted testimonies; and could not be a servant to Mentelius, to whom the before mentioned writers ascribe the invention in 1440, though more ancient ones do not attempt to prove that he began to print before 1444 or 1447. Nor will the narrative agree better with Gutenberg, who was an earlier printer than Mentelius; since, among the evidences produced by him in his law-suit, 1439, no Geinsfleisch senior appears, nor any other servant but Laurentius Beildek. The narration therefore of the theft of Geinsfleisch, being spread by various reports through the world, and subsisting in the time of these chronologers, was applied by them (to serve the cause they wrote for) to Strasburg; but serves to confirm the truth, since no writer derives the printing spoils from any other country than Holland or Alfatia. The chronologers have likewise, instead of Fust, called Gutenberg the wealthy man; who, from all circumstances, appears to have been poor. They also call Schoeffer the son-in-law of Mentelius; when it is clear that he married the daughter of Fust.

(D) Many writers have supposed that this was the edition of which some copies were sold in France, by Fust, as manuscripts, for the great price of 500 or 600 crowns, which he afterwards lowered to 60, and at last to less than 40. But it was the second and more expensive edition of 1462, that was thus disposed of, when Fust went to Paris in 1466, and which had cost 4000 florins before the third *quaternion* (or quire of four sheets) was printed. MEERMAN, vol. I. p. 6. 151, 152.

(E) At the death of Gutenberg, Conrad Humery took possession of all his printing materials; and engaged to the archbishop Adolphus, that he never would sell them to any one but a citizen of Mentz. They were, however, soon disposed of to Nicholas Bechtermuntze of Altavilla, who, in 1469, published *Vocabularium Latino-Teutonicum*, which was printed with the same types which had been used in the *Catholicon*. This very curious and scarce *Vocabulary* was shown to Mr Meerman, by Mr Bryant, in the Duke of Marlborough's valuable library at Blenheim. It is in quarto, 35 lines long, contains many extracts from the *Catholicon*, and is called *Ex quo*, from the preface beginning with those words. MEERMAN, vol. II. p. 96.

(F) Gutenberg never used any other than either *wooden* or *cut metal types* till the year 1462. In 1465 he was admitted *inter Aulicos* by the elector Adolphus, with an annual pension; and died in February 1468. His elder brother Geinsfleisch died in 1462. Their epitaphs are printed by Mr Meerman, vol. II. p. 154, 295.

Printing.
8
Invention
of cast
types.

through its *second* period, the invention of *cut metal types*. But the honour of completing the discovery is due to PETER SCHOEFFER (G) de Gernsheim.

A very clear account of this final completion of the types is preserved by Trithemius (H). *Post hæc inventis successerunt subtiliora, inveneruntque modum fundendi formas omnium Latini alphabeti literarum, quas ipsi matrices nominabant: ex quibus rursus æneis sive stanneis characteres fundebant, ad omnem pressuram sufficientes, quos prius manibus sculpebant. Et revera sicuti ante xxx ferme annos ex ore Petri Opilionis de Gernsheim, civis Moguntini, qui gener erat primi artis inventoris, audivi, magnam a primo inventionis sue hæc ars impressoria habuit difficultatem.— Petrus autem memoratus Opilio, tunc famulus postea gener, sicut diximus, inventoris primi, Johannis Fust, homo ingeniosus et prudens, faciliorem modum fundendi characteres excogitavit, et artem, ut nunc est, complevit.*

Another ample testimony in favour of Schoeffer is given by Jo. Frid. Faustus of Aschaffenburg, from papers preserved in his family: "Peter Schoeffer of Gernsheim, perceiving his master Fust's design, and being himself ardently desirous to improve the art, found out (by the good providence of God) the method of cutting (*inciendi*) the characters in a *matrix*, that the letters might easily be singly *cast*, instead of being *cut*. He privately *cut matrices* for the whole alphabet; and when he showed his master the letters cast from these matrices, Fust was so pleased with the contrivance, that he promised Peter to give him his only daughter, Christina, in marriage; a promise which he soon after performed. But there were as many difficulties at first with these letters, as there had been before with *wooden* ones; the metal being too soft to support the force of the impression: but this defect was soon remedied, by mixing the metal with a substance which sufficiently hardened it (I)."

Fust and Schoeffer concealed this new improvement, by administering an oath of secrecy to all whom they intrusted, till the year 1462; when, by the dispersion of their servants into different countries, at the sacking of Mentz by the archbishop Adolphus, the invention was publicly divulged.

The first book printed with these *improved types* was *Durandi Rationale*, in 1459; at which time, however,

they seem to have had only *one size of cast letters*, all the larger characters which occur being *cut types*, as appears plainly by an inspection of the book. From this time to 1466, Fust and Schoeffer continued to print a considerable number of books; particularly two famous editions of *Tully's Offices*. In their earliest books, they printed more copies on *vellum* than on *paper*, which was the case both of their *Bibles* and *Tully's Offices*. This, however, was soon inverted; and *paper* introduced for the greatest part of their impressions; a few only being printed on *vellum* for curiosities, and for the purpose of being *illuminated*. How long Fust lived, is uncertain; but in 1471 we find Schoeffer was in partnership with *Conrad Henlis* and a kinsman of his master Fust. He published many books after the death of his father-in-law; the last of which that can be discovered is a third edition of the *Psalter* in 1490, in which the old *cut types* of the first edition were used.

IV. With regard to the claim of STRASBURG: Claim of Strasburg. It has been already mentioned, that Gutenberg was engaged in that city in different employments; and, among others, in endeavouring to attain the art of printing. That these endeavours were unsuccessful, is plain from an authentic judicial decree of the senate of Strasburg in 1439, after the death of Andrew Drizehen (K).

But there are many other proofs that Gutenberg and his partners were never able to bring the art to perfection.

1. Wimpfelingius*, the oldest writer in favour of Strasburg, tells us, that Gutenberg was the inventor of "a new art of writing," *ars impressoria*, which might also be called a *divine benefit*, and which he happily completed at Mentz; but does not mention one book of his printing: though he adds, that Mentelius printed many volumes correctly and beautifully, and acquired great wealth; whence we may conclude that he perfected what Gutenberg had in vain essayed.

2. Wimpfelingius, in another book†, tells us, the art of printing was found out by Gutenberg *incomplete*; which implies, not that he practised the art in an imperfect manner (as Laurentius had done at Harlem), but rather that he had not been able to accomplish what he aimed at.

3. Gutenberg, when he left Strasburg in 1444 or the

(G) In German, Schoeffer; in Latin, *Opilio*; in English, *Shepherd*.—He is supposed by Mr Meerman to have been the first engraver on copperplates.

(H) *Annales Hirsaugienses*, tom. ii. ad ann. 1450.—As this book was finished in 1514, and Trithemius tells us he had the narrative from Schoeffer himself about 30 years before; this will bring us back to 1484, when Schoeffer must have been advanced in years, and Trithemius about 22 years old, who died in 1516. See *Voss. Hist. Lat. l. i. c. 10. Fabr. Med. & Infim. Æt. l. 9.*

(I) See Meerman, vol. I. 9. 183. who copied this testimony from Wolfius, *Monument. Typograph.* vol. i. p. 468. seq.

(K) Their first attempts were made about 1436 with *wooden types*. Mr Meerman is of opinion that Geinsfleisch junior (who was of an enterprising genius, and had already engaged in a variety of projects) gained some little insight into the business by visiting his brother who was employed by Laurentius at Haerleim, but not sufficient to enable him to practise it. It is certain that, at the time of the law-suit in 1439, much money had been expended, without any profit having arisen; and the unfortunate Drizehen, in 1438, on his death-bed, lamented to his confessor, that he had been at great expence, without having been reimbursed a single *obolus*. Nor did Gutenberg (who persisted in his fruitless endeavours) reap any advantage from them; for, when he quitted Strasburg, he was overwhelmed in debt, and under a necessity of selling every thing he was in possession of. [MEERMAN, vol. I. p. 198—202.] All the depositions in the law-suit above-mentioned (with the judicial decree) are printed by Mr Meerman, vol. II. p. 58—88. N.

Printing.

the following year, and entered into partnership with Geinsfleisch senior and others, had occasion for his brother's assistance to enable him to complete the art; which shows that his former attempts at Strasburg had been unsuccessful ‡.

‡ Meerman, ut supra.

|| Annal. Hirsau. ut supra, et Chron. Sponheim.

See Meerman, vol. ii. p. 103. 127.

* Chronicon Coloniz, 1499.

4. These particulars are remarkably confirmed by Trithemius, who tells us, in two different places||, that Gutenberg spent all his substance in quest of this art; and met with such insuperable difficulties, that, in despair, he had nearly given up all hopes of attaining it, till he was assisted by the liberality of Fust, and by his brother's skill, in the city of Mentz.

5. Ulric Zell says * the art was completed at Mentz; but that some books had been published in Holland earlier than in that city. Is it likely that Zell, who was a German, would have omitted to mention Strasburg, if it had preceded Mentz in printing?

There is little doubt therefore that all Gutenberg's labours at Strasburg amounted to no more than a fruitless attempt, which he was at last under the necessity of relinquishing: and there is no certain proof of a single book having been printed in that city till after the dispersion of the printers in 1462, when Mentelius and Eggestenius successfully pursued the business.

In fine, the pretensions of *Strasburg* fall evidently to be set aside. And as to the other two cities, *Harlem* and *Mentz*, the disputes between them seem easily cleared up, from the twofold invention of printing above-mentioned: the first with *separate wooden types* at Harlem, by Laurentius, about 1430, and after continued by his family; the other with *METAL types*, first *cut*, and afterwards *cast*, which were invented at Mentz, but not used in Holland till brought thither by Theodoric Martens at Alost about 1472.

From this period printing made a rapid progress in most of the principal towns of Europe. In 1490, it reached Constantinople; and, according to Mr Palmer, p. 281, &c. it was extended, by the middle of the next century, to Africa and America. It was introduced into Russia about 1560: but, from motives either of policy or superstition, it was speedily suppressed by the ruling powers; and, even under the present enlightened empress, has scarcely emerged from its obscurity. — That it was early practised in the inhospitable regions of Iceland, we have the respectable authority of Mr Bryant: "Arngrim Jonas was born amidst the snows of Iceland; yet as much prejudiced in favour of his country as those who are natives of an happier climate. This is visible in his *Crymogæa*; but more particularly in his *Anatome Bleiskiniana*. I have in my possession this curious little treatise, written in Latin by him in his own country, and printed *Typis Holensibus in Islandiâ Boreali*, anno 1612. *Hola* is placed in some maps within the Arctic circle, and is certainly not far removed from it. I believe it is the farthest north of any place where arts and sciences have ever resided." *Observations and Inquiries relating to various parts of Ancient History*, 1767, p. 277.

10
Introduction of the art into Britain.

It was a constant opinion, delivered down by our historians, as hath been observed by Dr Middleton, that the Art of Printing was introduced and first practised in England by William Caxton, a mercer and citizen of London; who, by his travels abroad, and a residence of many years in Holland, Flanders, and Germany, in the affairs of trade, had an opportunity of informing himself of the whole

method and process of the art; and by the encouragement of the great, and particularly of the abbot of Westminster, first set up a press in that abbey, and began to print books soon after the year 1471.

This was the tradition of our writers; till a book, which had scarce been observed before the Restoration, was then taken notice of by the curious, with a date of its impression from Oxford, anno 1468, and was considered immediately as a clear proof and monument of the exercise of printing in that university several years before Caxton began to deal in it.

This book, which is in the public library at Cambridge, is a small volume of 41 leaves in 4to, with this title: *Expositio Sancti Jeronimi in Simbolum Apostolorum ad Papam Laurentium*: and at the end, *Explicit expositio, &c. Impressa Oxonie, & finita Anno Domini M.CCCC.LXVIII. XVII die Decembris.*

The appearance of this book has robbed Caxton of the first glory that he had long possessed, of being the author of printing in this kingdom; and Oxford has ever since carried the honour of the first press. The only difficulty was, to account for the silence of history in an event so memorable, and the want of any memorial in the university itself concerning the establishment of a new art amongst them of such use and benefit to learning. But this likewise has been cleared up by the discovery of a record, which had lain obscure and unknown at Lambeth-palace, in the Register of the See of Canterbury; and gives a narrative of the whole transaction, drawn up at the very time.

An account of this record was first published in a thin quarto volume, in English; with this title: "The Original and Growth of Printing, collected out of History and the Records of this Kingdome: wherein is also demonstrated, that Printing appertaineth to the Prerogative Royal, and is a Flower of the Crown of England. By Richard Atkyns, esq. — Whitehall, April the 25. 1664. By order and appointment of the right honourable Mr Secretary Morrice, let this be printed. Tho. Ryeaut. London: Printed by John Streeter, for the Author. 1664." 4to.

It sets forth in short, "That as soon as the art of printing made some noise in Europe, Thomas Bourchier, archbishop of Canterbury, moved the then king (Henry VI.) to use all possible means for procuring a printing-mould (for so it was then called) to be brought into this kingdom. The king (a good man, and much given to works of this nature) readily hearkened to the motion; and, taking private advice how to effect his design, concluded it could not be brought about without great secrecy, and a considerable sum of money given to such person or persons as would draw off some of the workmen of Harlem in Holland; where John Gutenberg had newly invented it, and was himself personally at work. It was resolved, that less than 1000 marks would not produce the desired effect; towards which sum the said archbishop presented the king 300 marks. The money being now prepared, the management of the design was committed to Mr Robert Turnour; who then was master of the robes to the king, and a person most in favour with him of any of his condition. Mr Turnour took to his assistance Mr Caxton, a citizen of good abilities, who traded much into Holland; which was a creditable pretence, as well for his going, as stay in the Low Countries. Mr Turnour was in disguise (his

Printing. (his beard and hair shaven quite off); but Mr Caxton appeared known and public. They, having received the said sum of 1000 merks, went first to Amsterdam, then to Leyden, not daring to enter Harlem itself; for the town was very jealous, having imprisoned and apprehended divers persons who came from other parts for the same purpose. They staid till they had spent the whole thousand merks in gifts and expences: so as the king was fain to send 500 merks more, Mr Turnour having written to the king that he had almost done his work; a bargain, as he said, being struck betwixt him and two Hollanders, for bringing off one of the under-workmen, whose name was Frederick Corfellis (or rather Corfellis), who late one night stole from his fellows in disguise into a vessel prepared before for that purpose; and so, the wind favouring the design, brought him safe to London. It was not thought so prudent to set him on work at London: but, by the archbishop's means (who had been vice-chancellor and afterwards chancellor of the university of Oxon) Corfellis was carried with a guard to Oxon; which guard constantly watched, to prevent Corfellis from any possible escape, till he had made good his promise in teaching them how to print. So that at Oxford printing was first set up in England, which was before there was any printing-press or printer in France, Spain, Italy, or Germany (except the city of Mentz), which claims seniority, as to printing, even of Harlem itself, calling her city, *Urbem Moguntinam artis typographicæ inventricem primam*; though it is known to be otherwise, that city gaining the art by the brother of one of the workmen of Harlem, who had learnt it at home of his brother, and after set up for himself at Mentz. This press at Oxon was at least ten years before there was any printing in Europe, except at Harlem and Mentz, where it was but new-born. This press at Oxford was afterwards found inconvenient to be the sole printing-place of England; as being too far from London and the sea. Wherefore the king set up a press at St Alban's, and another in the city of Westminster, where they printed several books of *divinity and physic*: for the king (for reasons best known to himself and council) permitted then no law-books to be printed; nor did any printer exercise that art, but only such as were the king's sworn servants; the king himself having the price and emolument for printing books.—By this means the art grew so famous, that anno primo Richard III. c. 9. when an act of parliament was made for restraint of aliens for using any handicrafts here (except as servants to natives), a special proviso was inserted, that strangers might bring in printed or written books to sell at their pleasure, and exercise the art of printing here, notwithstanding that act: so that in the space of 40 or 50 years, by the indulgence of Edward IV. Edward V. Richard III. Henry VII. and Henry VIII. the English proved so good proficients in printing, and grew so numerous, as to furnish the kingdom with books; and so skilful, as to print them as well as any beyond the seas; as appears by the act 25 Hen. VIII. c. 15. which abrogates the said proviso for that reason. And it was further enacted in the said statute, that if any person bought foreign books bound, he should pay 6s. 8d. per book. And it was further provided and enacted, that in case the said printers or sellers of books were unreasonable in their prices, they should be moderated by the lord chancellor, lord treasurer, the two lords

chief justices, or any two of them; who also had power to fine them 3s. 4d. for every book whose price should be enhanced.—But when they were by charter incorporated with *bookbinders, booksellers, and founders of letters*, 3 & 4 Philip and Mary, and called *The Company of Stationers*—they kick'd against the power that gave them life, &c.—Queen Elisabeth, the first year of her reign, grants by patent the privilege of sole printing all books that touch or concern the common laws of England, to Tottel a servant to her majesty, who kept it entire to his death; after him, to one Yest Weirt, another servant to her majesty; after him, to Weight and Norton; and after them, king James grants the same privilege to More, one of the signet; which grant continues to this day, &c."

From the authority of this record, all our later writers declare Corfellis to be the first printer in England; Mr Anthony Wood, the learned Mr Maittaire, Palmer, and one John Bagford, an industrious man, who had published proposals for an History of Printing, (Phil. Trans. for April 1707). But Dr Middleton has called in question the authenticity of this account, and has urged several objections to it, with the view of supporting Caxton's title to the precedence with respect to the introduction of the art into this country; of which we shall quote one or two, with the answers that have been made to them.

Objection 1.—“The silence of Caxton concerning a fact in which he is said to be a principal actor, is a sufficient confutation of it: for it was a constant custom with him, in the prefaces or conclusions of his works, to give an historical account of all his labours and transactions, as far as they concerned the publishing and printing of books. And, what is still stronger, in the continuation of the Polychronicon, compiled by himself, and carried down to the end of Henry the sixth's reign, he makes no mention of the expedition in quest of a printer: which he could not have omitted, had it been true; whilst in the same book he takes notice of the invention and beginning of printing in the city of Mentz.”

Answer.—As Caxton makes no mention in his Polychronicon of his expedition in quest of a printer; so neither does he of his bringing the art into England, which it is as much a wonder he should omit as the other. And as to his saying that the invention of printing was at Mentz, he means, of printing on fusile separate types. In this he copies, as many others have, from the *Fasciculus Temporum*; a work written in 1470, by Wernerus Rolevinch de Laer, a Carthusian monk, a MS. copy of which was in the library of Gerard Jo. Vossius (see lib. iii. de Hist. Latin. c. 6.); and afterwards continued to the year 1474, when it was first printed at Cologne typis Arnoldi ter Huernen. It was republished in 1481 by Heinrichus Wirzburgh de Vach, a Cluniac monk, without mentioning the name either of the printer or of the place of publication. It is plain that Caxton had one at least, or more probably both, of these editions before him, when he wrote his continuation of Polychronicon, as he mentions this work in his preface, and adopts the sentiments of its editor. (See MEERMAN, vol. ii. p. 37. and his *Documenta*, N° VII. XXIV. and XXV.)

Obj. 2.—“There is a farther circumstance in Caxton's history, that it seems inconsistent with the record; for we find him still beyond sea, about twelve years after the

Printing.

12

Whether
Caxton or
Corfellis
was the
first printer.

Printing the supposed transactions, "learning with great charge and trouble the art of printing" (*Recule of the Histories of Troye*, in the end of the 2d and 3d books); which he might have done with ease at home, if he had got Corfellis into his hands, as the record imports, so many years before: but he probably learnt it at Cologne, where he resided in 1471, (*Recule*, &c. *ibid.*), and whence books had been first printed with date the year before."

Ans.—Caxton tells us, in the preface to *The History of Troye*, that he began that translation March 1. 1468, at Bruges; that he proceeded on with it at Ghent; that he finished it at Cologne in 1471; and printed it, probably, in that city with his own types. He was 30 years abroad, chiefly in Holland; and lived in the court of Margaret duchess of Burgundy, sister of Edward IV. It was therefore much easier to print his book at Cologne, than to cross the sea to learn the art at Oxford. But further, there was a special occasion for his printing it abroad. Corfellis had brought over so far the art of printing as he had learned it at Harlem, which was the method of printing on *wooden separate* types, having the face of the letter cut upon them. But the art of *casting* metal types being divulged in 1462 by the workmen of Mentz, Caxton thought proper to learn that advantageous branch before he returned to England. This method of casting the types was such an improvement, that they looked on it as the *original* of printing; and Caxton, as most others do, ascribes that to Mentz.—Caxton was an assistant with Turnour in getting off Corfellis; but it is nowhere supposed that he came with him into England. (See MEERMAN, vol. ii. p. 34. B.)

Obj. 3.—"As the Lambeth record was *never heard of before the publication of Atkyn's book*, so it has never since been seen or produced by any man; though the registers of Canterbury have on many occasions been diligently and particularly searched for it. They were examined, without doubt, very carefully by archbishop Parker, for the compiling his *Antiquities of the British Church*; where, in the life of Thomas Bouchier, tho' he congratulates that age on the noble and useful invention of printing, yet he is silent as to the introduction of it into England by the endeavours of that archbishop: nay, his giving the honour of the invention to Straßburg clearly shows that he knew nothing of the story of Corfellis conveyed from Harlem, and that the record was not in being in his time. Palmer himself owns, "That it is not to be found there now; for that the late earl of Pembroke assured him, that he had employed a person for some time to search for it, but in vain:" (*Hist. of Printing*, p. 314.) On these grounds we may pronounce the record to be a forgery; though all the writers above-mentioned take pains to support its credit, and call it an *authentic piece*."

Atkyns, who by his manner of writing seems to have been a *bold and vain man*, might possibly be the inventor: for he had an interest in imposing it upon the world, in order to confirm the argument of his book, that *printing was of the prerogative royal*; in opposition to the *company of stationers*, with whom he was engaged in an expensive suit of law, in defence of the *king's patents*, under which he claimed *some exclusive powers of printing*. For he tells us, p. 3. "That, upon considering the thing, he could not but think that a public

person, more eminent than a mercer, and a public purse, must needs be concerned in so public a good: and the more he considered, the more inquisitive he was to find out the truth. So that he had formed his hypothesis before he had found his record; which he published, he says, as a friend to truth; not to suffer one man to be intitled to the worthy achievements of another; and as a friend to himself, not to lose one of his best arguments of entitling the king to this art." But, if Atkyns was not himself the contriver, he was imposed upon at least by some more crafty man; who imagined that his interest in the cause, and the warmth that he showed in prosecuting it, would induce him to swallow for genuine whatever was offered of the kind."

Ans.—On the other hand, is it likely that Mr Atkyns would dare to *forge* a record, to be laid before the king and council, and which his adversaries, with whom he was at law, could disprove?—(2.) He says he received this history from a person of honour, who was some time keeper of the Lambeth library. It was easy to have confuted this evidence, if it was false, when he published it, April 25. 1664.—(3.) John Bagford (who was born in England 1651, and might know Mr Atkyns, who died in 1677), in his *History of Printing at Oxford*, blames those who doubted of the authenticity of the Lambeth MS.; and tells us that he knew Sir John Birkenhead had an authentic copy of it, when in 1665 [which Bagford by some mistake calls 1664, and is followed in it by Meerman] he was appointed by the house of commons to draw up a bill relating to the exercise of that art. This is confirmed by the Journals of that house, Friday Oct. 27. 1665. vol. VIII. p. 622. where it is ordered, that this Sir John Birkenhead should carry the bill on that head to the house of lords for their consent.—The act was agreed to in the upper house on Tuesday Oct. 31. and received the royal assent on the same day; immediately after which the parliament was prorogued. See *Journals of the House of Lords*, Vol. XI. p. 700.—It is probable, then, that after Mr Atkyns had published his book in April 1664, the parliament thought proper, the next year, to inquire into the *right of the king's prerogative*; and that Sir John Birkenhead took care to inspect the original, then in the custody of archbishop Sheldon: and, finding it not sufficient to prove what Mr Atkyns had cited it for, made no report of the MS. to the house; but only moved, that the former law should be renewed. The MS. was probably never returned to the proper keeper of it; but was afterwards burnt in the fire of London, Sept. 13. 1666.—(4.) That printing was practised at Oxford, was a prevailing opinion long before Atkyns. Bryan Twyne, in his *Apologia pro Antiquitate Academiae Oxoniensis*, published 1608, tells us, it is so delivered down in *ancient writings*; having heard, probably, of this Lambeth MS. And king Charles I. in his letters patent to the University of Oxford, March 5. in the eleventh of his reign, 1635, mentions printing as brought to *Oxford* from abroad. As to what is objected, "that it is not likely that the press should undergo a ten or eleven years sleep, viz. from 1468 to 1479," it is probably urged without foundation. Corfellis might print several books without date or name of the place, as Ulric Zell did at Cologne, from 1467 to 1473, and from that time to 1494. Corfellis's name, it may be said, appears not in any of his publications; but neither does

Printing. that of Joannes Petershemius. [See MEERMAN, vol. I. p. 34.; vol. II. p. 21—27, &c.]

Further, the famous Shakespeare, who was born in 1564, and died 1616, in the Second Part of Henry VI. act iv. sc. 7. introduces the rebel John Cade, thus upbraiding Lord Treasurer Say: "Thou hast most traiterously corrupted the youth of the realm, in creating a grammar-school: and whereas, before, our forefathers had no other book but the score and the tally, thou hast caused *Printing* to be used; and, contrary to the king, his crown, and dignity, thou hast built a paper-mill."—Whence now had Shakespeare this accusation against lord Say? We are told in the Poetical Register, vol. II. p. 231. ed. Lond. 1724, that it was from Fabian, Pol. Vergel, Hall, Hollingshed, Grafton, Stow, Speed, &c. But not one of these ascribes printing to the reign of Henry VI. On the contrary, Stow, in his Annals, printed at London 1560, p. 686, gives it expressly to William Caxton, 1471. "The noble science of printing was about this time found out in Germany at Magunee, by one John Guthumburgus a knight. One Conradus an Almaine brought it into Rome: William Caxton of London mercer, brought it into England about the year 1471, and first practised the same in the Abbie of St Peter at Westminster; after which time it was likewise practised in the Abbies of St Augustine at Canterbury, Saint Albons, and other monasteries of England." What then shall we say, that the above is an anachronism arbitrarily put into the mouth of an ignorant fellow out of Shakespeare's head? We might believe so, but that we have the record of Mr Atkyns confirming the same in king Charles II.'s time. Shall we say, that Mr Atkyns borrowed the story from Shakespeare, and published it with some improvements of money laid out by Henry VI. from whence it might be received by Charles II. as a prerogative of the crown? But this is improbable, since Shakespeare makes Lord Treasurer Say the instrument of importing it, of whom Mr Atkyns mentions not a word. Another difference there will still be between Shakespeare and the Lambeth MS.; the poet placing it before 1449, in which year Lord Say was beheaded; the MS. between 1454 and 1459, when Bouchier was archbishop. We must say, then, that lord Say first laid the scheme, and sent some one to Harlem, though without success; but after some years it was attempted happily by Bouchier. And we must conclude, that as the generality of writers have overlooked the invention of printing at Harlem with *wooden* types, and have ascribed it to Mentz where *metal* types were first made use of; so in England they have passed by Corfellis (or the first *Oxford Printer*, whoever he was, who printed with *wooden* types at Oxford), and only mentioned Caxton as the original artist who printed with *metal* types at Westminster. [See MEERMAN, vol. ii. 7, 8.] It is strange, that the learned commentators on our great dramatic poet, who are so minutely particular upon less important occasions, should every one of them, Dr Johnson excepted, pass by this curious passage, leaving it entirely unnoticed. And how has Dr Johnson trifled, by slightly remarking, "that Shakespeare is a little *too early* with this accusation!"—The great critic had undertaken to decipher obsolete words, and investigate unintelligible phrases; but never, perhaps, bestowed a thought on Caxton or Corfellis, on

Mr Atkyns or the authenticity of the Lambeth Record. Printing.

But, independent of the record altogether, the book stands firm as a monument of the exercise of printing in Oxford six years older than any book of Caxton's with a date. In order to get clear of this strong fact Dr Middleton,

1. Supposes the date in question to have been falsified originally by the printer either by design or mistake; and an X to have been dropped or omitted in the age of its impression. Examples of this kind, he says, are common in the history of printing. And, "whilst I am now writing, an unexpected instance is fallen into my hands, to the support of my opinion; an *Inauguration Speech of the Woodwardian Professor, Mr Mason*, just fresh from the press, with its date given 10 years earlier than it should have been, by the omission of an x, viz. mccccxiv; and the very blunder exemplified in the last piece printed at Cambridge, which I suppose to have happened in the first from Oxford."—To this it has been very properly answered, That we should not pretend to set aside the authority of a *plain date*, without very strong and cogent reasons; and what the Doctor has in this case advanced will not appear, on examination, to carry that weight with it that he seems to imagine. There may be, and have been, mistakes and forgeries in the date both of books and of records too; but this is never allowed as a reason for suspecting such as bear no mark of either. We cannot from a blunder in the last book printed at Cambridge, infer a like blunder in the first book printed at Oxford. Besides, the *type* used in this our Oxford edition seems to be no small proof of its antiquity. It is the German letter, and very nearly the same with that used by Fust [who has been supposed to be] the first printer; whereas Caxton and Rood use a quite different letter, something between this German and our old English letter, which was soon after introduced by De Worde and Bynson.

2. "For the probability of his opinion (he says), the book itself affords sufficient proof: for, not to insist on what is less material, the *neatness of the letter*, and *regularity of the page*, &c. above those of Caxton, it has one mark, that seems to have carried the matter beyond probable, and to make it even certain, viz. *the use of signatures*, or letters of the alphabet placed at the bottom of the page, to show the sequel of the pages and leaves of each book; an improvement contrived for the direction of the bookbinders; which yet was not practised or invented at the time when this book is supposed to be printed; for we find no signatures in the books of Faust or Schoeffer at Mentz, nor in the improved or beautiful impressions of John de Spira and Jenfon at Venice, till several years later. We have a book in our library, that seems to fix the very time of their invention, at least in Venice; the place where the art itself received the greatest improvements: *Baldi lectura super Codic. &c.* printed by John de Colonia and Jo. Manthem de Gherretzem, anno mccccxxiiii. It is a large and fair volume in folio, *without signatures*, till about the middle of the book, in which they are first introduced, and so continued forward: which makes it probable, that the first thought of them was suggested during the impression; for we have likewise *Lectura Bartholi super Codic. &c.* in two noble and beautiful volumes in folio, printed
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Printing.

Printing.

the year before at the same place, by Vindelin de Spira, without them: yet from this time forward they are generally found in all the works of the Venetian printers, and from them propagated to the other printers of Europe. They were used at (L) Cologne, in 1475; at Paris, 1476; by Caxton, not before 1480: but if the discovery had been brought into England, and practised at Oxford 12 years before, it is not probable that he would have printed so long at Westminster without them. Mr Palmer indeed tells us, p. 54, 180, that Anthony Zarot was esteemed the inventor of signatures; and that they are found in a Terence printed by him at Milan in the year 1470, in which he first printed. I have not seen that Terence; and can only say, that I have observed the want of them in some later works of this, as well as of other excellent printers of the same place. But, allowing them to be in the Terence, and Zarot the inventor, it confutes the date of our Oxford book as effectually as if they were of later origin at Venice; as I had reason to imagine, from the testimony of all the books that I have hitherto met with."—As to these proofs, first, the neatness of the letter, and the regularity of the page, prove, if any thing, the very reverse of what the Doctor asserts. The art of printing was almost in its infancy brought to perfection; but afterwards debased by later printers, who consulted rather the cheapness than the neatness of their work. Our learned dissertator cannot be unacquainted with the labours of Fust and Jenfon. He must know, that though other printers may have printed more correctly, yet scarce any excel them, either in the neatness of the letter, or the regularity of the page. The same may be observed in our English printers. Caxton and Rood were indifferently good printers; De Worde and Pynson were worse; and those that follow them most abominable. This our *anonymous Oxford printer* excels them all; and for this very reason we should judge him to be the most ancient of all. Our dissertator lays great stress on the use of signatures. But no certain conclusion can be drawn either from the use or non-use of these lesser improvements of printing. They have in different places come in use at different times, and have not been continued regularly even at the same places. If Anthony Zarot used them at Milan in 1470, it is certain later printers there did not follow his example; and the like might happen also in England. But, what is more full to our purpose, we have in the Bodleian library an *Æsop's Fables* printed by Caxton. This is, it is believed, the first book which has the *leaves numbered*. But yet this improvement, though more useful than that of the signatures, was disused both by Caxton himself and other later printers in England. It is therefore not at all surprising (if true) that

Vol. XV. Part II.

the signatures, though invented by our Oxford printer, might not immediately come into general use. And consequently, this particular carries with it no such certain or effectual confutation as our dissertator boasts of.

3. What the Doctor thinks farther confirms his opinion is, "That, from the time of the pretended date of this book, *anno* 1468, we have no other fruit or production from the press at Oxford for 11 years next following; and it cannot be imagined that a press, established with so much pains and expence, could be suffered to be so long idle and useless."—To this it may be answered, in the words of Oxonides, 1st, That his books may have been lost. Our first printers, in those days of ignorance, met with but small encouragement; they printed but few books, and but few copies of those books. In after-times, when the same books were reprinted more correctly, those first editions, which were not as yet become curiosities, were put to common uses. This is the reason that we have so few remains of our first printers. We have only four books of Theodorico Rood, who seems by his own verses to have been a very celebrated printer. Of John Lettou-William de Machlinia, and the schoolmaster of St Alban's, we have scarce any remains. If this be considered, it will not appear *impossible* that our printer should have followed his business from 1468 to 1479, and yet time have destroyed his intermediate works. But, 2dly, We may account still another way for this distance of time, without altering the date. The Civil Wars broke out in 1469: this might probably oblige our Oxford printer to shut up his press; and both himself and his readers be otherwise engaged. If this were the case, he might not return to his work again till 1479; and the next year, not meeting with that encouragement he deserved, he might remove to some other country with his types.

Dr Middleton concludes with apologizing for his "spending so much pains on an argument so inconsiderable, to which he was led by his zeal to do a piece of justice to the memory of our worthy countryman William Caxton; nor suffer him to be robbed of the glory, so clearly due to him, of having *first imported into this kingdom* an art of great use and benefit to mankind: a kind of merit that, in the sense of all nations, gives the best title to true praise, and the best claim to be commemorated with honour to posterity."

The fact, however, against which he contends, but which it seems impossible to overturn, does by no means derogate from the honour of Caxton, who, as has been shown, was the first person in England that practised the art of printing with *fusile types*, and consequently the first who brought it to perfection; whereas Corfellis printed with *separate cut types in wood*, being the only method

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which

(L) Dr Middleton is mistaken in the time and place of the invention of signatures. They are to be found even in very ancient MSS. which the earliest printers very studiously imitated; and they were even used in some editions from the office of Lawrence Coster (whence Corfellis came), which consisted of wooden cuts, as in *Figura typica et antitypica Novi Testamenti*; and in some editions with metal types, as in *Gasp. Pergamenis epistole*, published at Paris, without a date, but printed A. D. 1470, (Maittaire*, *Annal.* vol. i. p. 25.); and in *Mammetrellus*, printed by Helias de Llouffen, at Bern in Switzerland, 1470; and in *De Tondeli visione*, at Antwerp, 1472. Venice, therefore, was not the place where they were first introduced.—They began to be used in *Baldus*, it seems, when the book was half finished. The printer of that book might not know, or did not think, of the use of them before. See *Meerman*, vol. ii. p. 18.; and *Phil. Transf.* vol. xxiii. n^o 208. p. 1509.

13
The real
claims of
Caxton and
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Printing. which he had learned at Harlem. Into this detail, therefore, we have been led, not so much by the importance of the question, as on account of several anecdotes connected with it, which seemed equally calculated to satisfy curiosity and afford entertainment.

Caxton had been bred very reputably in the way of trade, and served an apprenticeship to one Robert Large a mercer; who, after having been sheriff and lord mayor of London, died in the year 1441, and left by will, as may be seen in the prerogative-office, xxiiii merks to his apprentice William Caxton: a considerable legacy in those days, and an early testimonial of his good character and integrity.

From the time of his master's death, he spent the following thirty years beyond sea in the business of merchandize: where, in the year 1464, we find him employed by Edward IV. in a public and honourable negotiation, jointly with one Richard Whitehill, Esq; to transact and conclude a treaty of commerce between the king and his brother-in-law the duke of Burgundy, to whom Flanders belonged. The commission styles them, *ambassiatores, procuratores, nuncios, & deputatos speciales*; and gives to both or either of them full powers to treat, &c.

Whoever turns over his printed works, must contract a respect for him, and be convinced that he preserved the same character through life, of an honest, modest, man; greatly industrious to do good to his country, to the best of his abilities, by spreading among the people such books as he thought useful to religion and good manners, which were chiefly translated from the French. The novelty and usefulness of his art recommended him to the special notice and favour of the great; under whose protection, and at whose expence, the greatest part of his works were published. Some of them are addressed to king Edward IV. his brother the duke of Clarence, and their sister the duchess of Burgundy; in whose service and pay he lived many years before he began to print, as he often acknowledges with great gratitude. He printed likewise for the use, and by the express order, of Henry VII. his son prince Arthur, and many of the principal nobility and gentry of that age.

It has been generally asserted and believed, that all his books were printed in the abbey of Westminster; yet we have no assurance of it from himself, nor any mention of the place before the year 1477: so that he had been printing several years without telling us where.

There is no clear account left of Caxton's age: but he was certainly very old, and probably above fourscore, at the time of his death. In the year 1471 he complained of the infirmities of age creeping upon him, and feebling his body: yet he lived 23 years after, and pursued his business, with extraordinary diligence, in the abbey of Westminster, till the year 1494, in which he died; not in the year following; as all who write of him affirm. This appears from some verses at the end of a book, called "Hilton's Scale of Perfection," printed in the same year:

Infynite laud with thankynges many folde
I yield to God me focouryng with his grace
This boke to synshe which that ye beholde
Scale of Perfection calde in every place

Whereof th' auctor Walter Hilton was

And Wynkyn de Worde this hath sett in print

In William Caxtons hows so fyll the case,

God rest his soule. In joy ther mot it stynt.

Impressus anno salutis MCCCCLXXXxiii.

Though he had printed for the use of Edward IV. and Henry VII. yet there appears no ground for the notion which Palmer takes up, that the first printers, and particularly Caxton, were sworn servants and printers to the crown; for Caxton, as far as can be observed, gives not the least hint of any such character or title; though it seems to have been instituted not long after his death; for of his two principal workmen, Richard Pynson and Wynkyn de Worde, the one was made printer to the king, the other to the king's mother the Lady Margaret. Pynson gives himself the first title, in *The imitation of the Life of Christ*; printed by him at the commandment of the Lady Margaret, who had translated the fourth book of it from the French, in the year 1504: and Wynkyn de Worde assumes the second, in *The seven Penitential Psalms*, expounded by Bishop Fisher, and printed in the year 1509. But there is the title of a book given by Palmer, that seems to contradict what is here said of Pynson: viz. *Psalterium ex mandato victoriosissimi Anglie Regis Henrici Septimi, per Gulielmum Fanque, impressorem regium, anno MDiiii*; which being the only work that has ever been found of this printer, makes it probable that he died in the very year of its impression, and was succeeded immediately by Richard Pynson. No book hath yet been discovered printed in Scotland in this period, though the English printers were able to export some of their works to other countries. See Henry's *History of Great Britain*, vol. v. p. 471.

Before 1465, the uniform character was the old Gothic or German; whence our Black was afterwards formed. But in that year an edition of Lactantius was printed in a kind of Semi-Gothic, of great elegance; and approaching nearly to the present Roman type; which last was first used at Rome in 1467, and soon after brought to great perfection in Italy, particularly by Jensen.

Towards the end of the 5th century, Aldus invented the *Italic* character which is now in use, called, from his name, *Aldine* or *cursius*. This sort of letter he contrived, to prevent the great number of abbreviations that were then in use.

The first essays in Greek that can be discovered are a few sentences which occur in the edition of Tully's *Offices*, 1465, at Mentz; but these were miserably incorrect and barbarous, if we may judge from the specimens Mr Maittaire has given us, of which the following is one:

Οτι κατακαταστρατα και τατατατα.

In the same year; 1465, was published an edition of Lactantius's *Institutes*, printed in *monasterio Sublacensi*, in the kingdom of Naples, in which the quotations from the Greek authors are printed in a very neat Greek letter. They seem to have had but a very small quantity of Greek types in the monastery; for, in the first part of the work, whenever a long sentence occurred, a blank was left, that it might be written in with a pen: after the middle of the work, however, all the Greek that occurs is printed.

Printing.

The first printers who settled at Rome were Conrad Sweynheim and Arnold Pannartz, who introduced the present Roman type, in 1466, in Cicero's *Epistolæ Familiæ*: in 1469 they printed a beautiful edition of *Aulus Gellius*, with the Greek quotations in a fair character, without accents or spirits, and with very few abbreviations.

The first whole book that is yet known is the Greek Grammar of Constantine Lascaris, in quarto, revised by Demetrius Cretensis, and printed by Dionysius Palavifinus, at Milan, 1476. In 1481, the Greek *Psalter* was printed here, with a Latin translation, in folio; as was *Æsop's Fables* in quarto.

Venice soon followed the example of Milan; and in 1486 were published in that city the Greek *Psalter* and the *Batrachomyomachia*, the former by Alexander, and the latter by Laonicus, both natives of Crete. They were printed in a very uncommon character; the latter of them with accents and spirits, and also with *scholia*.

In 1488, however, all former publications in this language were eclipsed by a fine edition of *Homer's Works* at Florence, in folio, printed by Demetrius, a native of Crete. Thus printing (says Mr Maittaire, p. 185.) seems to have attained its *ακμή* of perfection, after having exhibited most beautiful specimens of Latin, Greek, and Hebrew.

In 1493, a fine edition of *Isocrates* was printed at Milan, in folio, by Henry German and Sebastian ex Pantremulo.

All the above works are prior in time to those of Aldus, who has been erroneously supposed to be the first Greek printer: the beauty, however, correctness, and number of his editions, place him in a much higher rank than his predecessors; and his characters in general were more elegant than any before used. He was born in 1445, and died in 1515.

Though the noble Greek books of Aldus had raised an universal desire of reviving that tongue, the French were backward in introducing it. The only pieces printed by them were some quotations, so wretchedly performed, that they were rather to be guessed at than read; in a character very rude and uncouth, and without accents. But Francis Tiffard introduced the study of this language at Paris, by his *Βιβλος η γυναικαγωγικη*, in 1507; and that branch of printing was afterwards successfully practised by Henry, Robert, and Henry Stephens. See the article STEPHENS.

The earliest edition of the whole Bible was, strictly speaking, the Complutensian Polyglott of Cardinal Ximenes; but as that edition, though finished in 1517, was not published till 1522, the Venetian Septuagint of 1518 may properly be called the first edition of the whole Greek Bible; Erasmus having published the New Testament only at Basil in 1516.

A very satisfactory account of Hebrew printing is thus given by Dr Kennicott in his *Annual Accounts of the Collation of Hebrew MSS.* p. 112. "The method which seems to have been originally observed in printing the Hebrew Bible was just what might have been expected: 1. The Pentateuch in 1482. 2. The Prior Prophets, in 1484. 3. The Posterior Prophets, in 1486. 4. The Hagiographa, in 1487. And, after the four great parts had been thus printed separately (each with a comment), the whole text (without a comment) was printed in one volume in 1488; and the text continue

to be printed, as in these first editions, so in several others for 20 or 30 years, without marginal *Keri* or *Mafora*, and with greater arguments to the more ancient MSS. till about the year 1520 some of the Jews adopted later MSS. and the *Mafora*; which absurd preference has obtained ever since."

Thus much for the ancient editions given by Jews.

In 1642 a Hebrew Bible was printed at Mantua under the care of the most learned Jews in Italy. This Bible had not been heard of among the Christians in this country, nor perhaps in any other; though the nature of it is very extraordinary. The text indeed is nearly the same with that in other modern editions; but at the bottom of each page are various readings, amounting in the whole to above 2000, and many of them of great consequence, collected from manuscripts, printed editions, copies of the Talmud, and the works of the most renowned Rabbies. And in one of the notes is this remark:—"That in several passages of the Hebrew Bible the differences are so many and so great, that they know not which to fix upon as the true readings."

We cannot quit this subject without observing, on Dr Kennicott's authority, that as the first printed Bibles are more correct than the latter ones; so the variations between the first edition, printed in 1488, and the edition of Vander Hooght, in 1705, at Amsterdam, in 2 vols 8vo, amount, upon the whole, to above 1200! See further *Bowyer and Nichols*, p. 112—117.

When the art of printing was first discovered, they only made use of one side of a page: they had not yet found out the expedient of impressing the other. When their editions were intended to be curious, they omitted to print the first letter of a chapter, for which they left a blank space, that it might be painted or illuminated at the option of the purchaser. Several ancient volumes of these early times have been found, where these letters are wanting, as they neglected to have them painted.

When the art of printing was first established, it was the glory of the learned to be correctors of the press to the eminent printers. Physicians, lawyers, and bishops themselves, occupied this department. The printers then added frequently to their names those of the correctors of the press; and editions were then valued according to the abilities of the corrector.

In the productions of early printing may be distinguished the various splendid editions they made of *Primers* or *Prayer-books*. They were embellished with cuts finished in a most elegant taste: many of them were ludicrous, and several were obscene. In one of them an angel is represented crowning the Virgin Mary, and God the Father himself assisting at the ceremony. We have seen in a book of natural history the Supreme Being represented as reading on the seventh day, when he reited from all his works. Sometimes St Michael is seen overcoming Satan; and sometimes St Anthony appears attacked by various devils of most hideous forms. The *Primer of Salisbury*, 1533, is full of cuts: at the bottom of the title page there is the following remarkable prayer:

God be in my Bede,
And in my Understandynge.
God be in my Eyen,
And in my Lokynge.

3 U 2

God

Printing.

17
Anecdotes
of early
printing.

16
Of the first
Hebrew
printing

Printing.

God be in my Mouthe,
And in my Spekyuge.
God be in my Herte,
And in my thinkinge.
God be at myn ende,
And at my departynge.

18
Method of
printing.

The workmen employed in the art of printing are of two kinds: compositors, who range and dispose the letters into words, lines, pages, &c. according to the copy delivered them by the author; and pressmen, who apply ink upon the same, and take off the impression. The types being cast, the compositor distributes each kind by itself among the divisions of two wooden frames, an upper and an under one, called *cases*; each of which is divided into little cells or boxes. Those of the upper case are in number 98: these are all of the same size; and in them are disposed the capitals, small capitals, accented letters, figures, &c. the capitals being placed in alphabetical order. In the cells of the lower case, which are 54, are placed the small letters, with the points, spaces, &c. The boxes are here of different sizes, the largest being for the letters most used; and these boxes are not in alphabetical order, but the cells which contain the letter oftenest wanted are nearest the compositor's hand. Each case is placed a little aslope, that the compositor may the more easily reach the upper boxes. The instrument in which the letters are set is called a *composing-stick* (n^o 1.), which consists of a long and narrow plate of brass or iron, &c. on the right side of which arises a ledge, which runs the whole length of the plate, and serves to sustain the letters, the sides of which are to rest against it; along this ledge is a row of holes, which serve for introducing the screw *a*, in order to lengthen or shorten the extent of the line, by moving the sliders *b c* farther from or nearer to the shorter ledge at the end *d*. Where marginal notes are required in a work, the two sliding pieces *b c* are opened to a proper distance from each other in such a manner as that while the distance between *d c* forms the length of the line in the text, the distance between the two sliding-pieces forms the length of the lines for the notes on the side of the page. Before the compositor proceeds to compose, he puts a rule or thin slip of brass-plate, cut to the length of the line, and of the same height as the letter, in the composing-stick, against the ledge, for the letter to bear against. Things thus prepared, the compositor having the copy lying before him, and his stick in his left-hand, his thumb being over the slider *c*; with the right he takes up the letters, spaces, &c. one by one, and places them against the rule, while he supports them with his left thumb by pressing them to the end of the slider *c*, the other hand being constantly employed in setting in other letters: the whole being performed with a degree of expedition and address not easy to be imagined.

A little being thus composed, if it end with a word or syllable, and exactly fill the measure, there needs no further care; otherwise, more spaces are to be put in, or else the distances lessened, between the several words, in order to make the measure quite full, so that every line may end even. The spaces here used are pieces of metal exactly shaped like the shanks of the letters: they are of various thickneses, and serve to support the letters, and to preserve a proper distance between the

words; but not reaching so high as the letters, they make no impression when the work is printed. The first line being thus finished, the compositor proceeds to the next; in order to which he moves the brass-rule from behind the former, and places it before it, and thus composes another line against it after the same manner as before; going on thus till his stick is full, when he empties all the lines contained in it into the gally.

The compositor then fills and empties his composing-stick as before, till a complete page be formed; when he ties it up with a cord or pack-thread; and setting it by, proceeds to the next, till the number of pages to be contained in a sheet is completed; which done, he carries them to the imposing-stone, there to be ranged in order, and fastened together in a frame called a *chase*; and this is termed *imposing*. The chase is a rectangular iron frame, of different dimensions according to the size of the paper to be printed, having two cross-pieces of the same metal, called a *long* and *short cross*, mortised at each end so as to be taken out occasionally. By the different situations of these crosses the chase is fitted for different volumes: for quartos and octavos, one traverses the middle lengthwise, the other broadwise, so as to intersect each other in the centre: for twelves and twenty-fours, the short cross is shifted nearer to one end of the chase; for folios, the long cross is left entirely out, and the short one left in the middle; and for broad-sides, both crosses are set aside. To dress the chase, or range and fix the pages therein, the compositor makes use of a set of furniture, consisting of slips of wood of different dimensions, and about half an inch high, that they may be lower than the letters: some of these are placed at the top of the pages, and called *beat-sticks*; others between them, to form the inner margin; others on the sides of the crosses, to form the outer margin, where the paper is to be doubled; and others in the form of wedges to the sides and bottoms of the pages. Thus all the pages being placed at their proper distances, and secured from being injured by the chase and furniture placed about them, they are all untied, and fastened together by driving small pieces of wood called *quoins*, cut in the wedge-form, up between the slanting side of the foot and the side sticks and the chase, by means of a piece of hard wood and a mallet; and all being thus bound fast together, so that none of the letters will fall out, it is ready to be committed to the pressmen. In this condition the work is called a *form*; and as there are two of these forms required for every sheet, when both sides are to be printed, it is necessary the distances between the pages in each form should be placed with such exactness, that the impression of the pages in one form shall fall exactly on the back of the pages of the other, which is called *register*.

As it is impossible but that there must be some mistakes in the work, either through the oversight of the compositor, or by the casual transposition of letters in the cases; a sheet is printed off, which is called a *proof*, and given to the corrector; who reading it over, and rectifying it by the copy, making the alterations in the margin, it is delivered back to the compositor to be corrected.

The compositor then unlocking the form upon the correcting-stone, by loosening the quoins or wedges which bound the letters together, rectifies the mistakes by

Plate
CCCCXV.

Printing. by picking out the faulty or wrong letters with a slender sharp-pointed steel-bodkin, and putting others into their places. After this another proof is made, sent to the author, and corrected as before; and lastly, there is another proof called a *revise*, which is made in order to see whether all the mistakes marked in the last proof are corrected.

The pressman's business is to work off the forms thus prepared and corrected by the compositor; in doing which there are four things required, paper, ink, balls, and a press. To prepare the paper for use, it is to be first wetted by dipping several sheets together in water: these are afterwards laid in a heap over each other; and to make them take the water equally, they are all pressed close down with a weight at the top. The ink is made of oil and lamp-black; for the manner of preparing which, see *Printing-Ink*. The balls, by which the ink is applied on the forms, are a kind of wooden funnels with handles, the cavities of which are filled with wool or hair, as is also a piece of alum leather or pelt nailed over the cavity, and made extremely soft by socking in urine and by being well rubbed. One of these the pressman takes in each hand; and applying one of them to the ink-block, daubs and works them together to distribute the ink equally; and then blackens the form which is placed on the press, by beating with the balls upon the face of the letter.

Plate
CCCCXV.

The printing-press, represented n^o 2. is a very curious though complex machine. The body consists of two strong cheeks *aa*, placed perpendicularly, and joined together by four cross-pieces; the cap *b*; the head *c*, which is moveable, being partly sustained by two iron pins or long bolts, that pass the cap; the till or shelf *dd*, by which the spindle and its apparatus are kept in their proper position; and the winter *e*, which bears the carriage, and sustains the effort of the press beneath. The spindle *f* is an upright piece of iron pointed with steel, having a male screw which goes into the female one in the head about four inches. Through the eye *g* of this spindle is fastened the bar *k*, by which the pressman makes the impression. The spindle passes through a hole in the middle of the till; and its point works into a brass pan or nut, supplied with oil, which is fixed to an iron plate let into the top of the platten. The body of the spindle is sustained in the centre of an open frame of polished iron, 1, 1, 2, 2, 3, 3, fixed to it in such a manner as, without obstructing its free play, to keep it in a steady direction; and at the same time to serve for suspending the platten. This frame consists of two parts; the upper called the *garter*, 1, 1; the under, called the *crane*, 2, 2. These are connected together by two short legs or bolts, 3, 3; which being fixed below in the two ends of the crane, pass upward, through two holes in the till, and are received at top into two eyes at the ends of the garter, where they are secured by screws. The carriage *ll* is placed a foot below the platten, having its fore-part supported by a prop called the *fore-slay*, while the other rests on the winter. On this carriage, which sustains the plank, are nailed two long iron bars or ribs; and on the plank are nailed short pieces of iron or steel called *cramp irons*, equally tempered with the ribs, and which slide upon them when the plank is turned in or out. Under the carriage is fixed a long piece of iron called the *spit*, with a double

Printing. wheel in the middle, round which leather-girts are fastened, nailed to each end of the plank: and to the outside of the spit is fixed a rounce *m*, or handle to turn round the wheel. Upon the plank is a square frame or coffin, in which is inclosed a polished stone on which the form *n* is laid; at the end of the coffin are three frames, viz. the two tympan and frisket: the tympan *o* are square, and made of three slips of very thin wood, and at the top a piece of iron still thinner; that called the *outer tympan* is fastened with hinges to the coffin: they are both covered with parchment; and between the two are placed blankets, which are necessary to take off the impression of the letters upon the paper. The frisket *p* is a square frame of thin iron, fastened with hinges to the tympan: it is covered with paper cut in the necessary places, that the sheet, which is put between the frisket and the great or outward tympan, may receive the ink, and that nothing may hurt the margins. To regulate the margins, a sheet of paper is fastened upon this tympan, which is called the *tympan sheet*; and on each side is fixed an iron point, which makes two holes in the sheet, which is to be placed on the same points when the impression is to be made on the other side. In preparing the press for working, the parchment which covers the outer tympan is wetted till it is very soft, in order to render the impression more equable; the blankets are then put in, and secured from slipping by the inner tympan: then while one pressman is beating the letter with the balls *q*, covered with ink taken from the ink-block, the other person places a sheet of white paper on the tympan-sheet; turns down the frisket upon it, to keep the paper clean and prevent its slipping; then bringing the tympan upon the form, and turning the rounce, he brings the form with the stone, &c. weighing about 300 lbs. weight, under the platten; pulls with the bar, by which means the platten presses the blankets and paper close upon the letter, whereby half the form is printed; then easing the bar, he draws the form still forward; gives a second pull; and letting go the bar, turns back the form, takes up the tympan and frisket, takes out the printed sheet, and lays on a fresh one; and this is repeated till he has taken off the impression upon the full number of sheets the edition is to consist of. One side of the sheet being thus printed, the form for the other is laid upon the press, and worked off in the same manner.

Chinese PRINTING, is performed from wooden planks or blocks, cut like those used in printing of callico, paper, cards, &c.

Rolling-press PRINTING, is employed in taking off prints or impressions from copperplates engraven, etched, or scraped, as in mezzotintos. See *ENGRAVING*.

This art is said to have been as ancient as the year 1540, and to owe its origin to Finiguerra, a Florentine goldsmith, who pouring some melted brimstone on an engraven plate, found the exact impression of the engraving left in the cold brimstone, marked with black taken out of the strokes by the liquid sulphur: upon this he attempted to do the same on silver plates with wet paper, by rolling it smoothly with a roller; and this succeeded: but this art was not used in England till the reign of king James I. when it was brought from Antwerp by Speed. The form of the rolling-press,

Printing.

press, the composition of the ink used therein, and the manner of applying both in taking off prints, are as follows.

Plate
CCCCXV

The rolling-press AL, no 3. may be divided into two parts, the body and carriage: the body consists of two wooden cheeks PP, placed perpendicularly on a stand or foot LM, which sustains the whole press. From the foot likewise are four other perpendicular pieces *c, c, c, c*, joined by other cross or horizontal ones *d, d, d*, which serve to sustain a smooth even plank or table HIK, about four feet and a half long, two feet and a half broad, and an inch and a half thick. Into the cheeks go two wooden cylinders or rollers, DE, FG, about six inches in diameter, borne up at each end by the cheeks, whose ends, which are lessened to about two inches diameter, and called *trunnions*, turn in the cheeks about two pieces of wood in form of half-moons, lined with polished iron to facilitate the motion. Lastly, to one of the trunnions of the upper roller is fastened a cross, consisting of two levers AB, or pieces of wood, traversing each other, the arms of which cross serve instead of the bar or handle of the letter-press, by turning the upper roller, and when the plank is between the two rollers, giving the same motion to the under one, by drawing the plank forward and backward.

The ink used for copperplates, is a composition made of the stones of peaches and apricots, the bones of sheep and ivory, all well burnt, and called *Frankfort black*, mixed with nut-oil that has been well boiled, and ground together on a marble, after the same manner as painters do their colours.

The method of printing from copperplates is as follows: They take a small quantity of this ink on a rubber made of linen-rags, strongly bound about each other, and therewith smear the whole face of the plate as it lies on a grate over a charcoal fire. The plate being sufficiently inked, they first wipe it over with a foul rag, then with the palm of their left hand, and then with that of the right; and to dry the hand and forward the wiping, they rub it from time to time in whiting. In wiping the plate perfectly clean, yet without taking the ink out of the engraving, the address of the workman consists. The plate thus prepared, is laid on the plank of the press; over the plate is laid the paper, first well moistened, to receive the impression; and over the paper two or three folds of flannel. Things thus disposed, the arms of the cross are pulled, and by that means the plate with its furniture passed through between the rollers, which pinching very strongly, yet equally, presses the moistened paper into the strokes of the engraving, whence it licks out the ink.

PRINTS, the impressions taken from a copperplate. See the last article, and ENGRAVING.

From the facility of being multiplied, prints have derived an advantage over paintings by no means inconsiderable. They are found to be more durable; which may, however, in some degree be attributed to the different methods in which they are preserved. Many of the best paintings of the early masters have generally had the misfortune to be either painted on walls, or deposited in large and unfrequented, and consequently damp and destructive, buildings; whilst a print, passing,

at distant intervals, from the *porte feuille* of one collector to that of another, is preserved without any great exertion of its owner: And hence it happens, that whilst the pictures of Raphael have mouldered from their walls, or deserted their canvas, the prints of his friend and contemporary Mark Antonio Raimondi continue in full perfection to this day, and give us a lively idea of the beauties of those paintings, which, without their assistance, had been lost to us for ever; or at least, could have been only known to us, like those of Zeuxis and Apelles, by the descriptions which former writers on these subjects have left us.

Independent of the advantages which prints afford us, when considered as accurate representations of paintings, and imitations of superior productions, they are no less valuable for their positive merit, as immediate representations of nature. For it must be recollected, that the art of engraving has not always been confined to the copying other productions, but has frequently itself aspired to originality, and has, in this light, produced more instances of its excellence than in the other. Albert Durer, Goltzius, and Rembrandt, amongst the Dutch and Germans; Parmigiano and Della Bella amongst the Italians, and Callot amongst the French, have published many prints, the subjects of which, there is great reason to suppose, were never painted. These prints may therefore be considered as original pictures of those masters, deficient only in those particulars in which a print must necessarily be inferior to a painting.

The preceding distinction may perhaps throw some light on the proper method of arranging and classing a collection of prints, which has been a matter of no small difficulty. As an art imitating another, the principal should take the lead, and the design, composition, and drawing, in a print, being previous requisites to the manner of execution and finishing; prints engraved after paintings should be arranged under the name of the painter; and every person who looks upon engraving only as auxiliary to painting, will consequently adopt this mode of arrangement. But when engraving is considered as an original art, as imitating nature without the intervention of other methods, then it will certainly be proper to regulate the arrangement according to the names of the engravers.

PRIOR, in general, something before or nearer the beginning than another, to which it is compared.

PRIOR, more particularly denotes the superior of a convent of monks, or the next under the abbot. See ABBOT.

Priors are either *claustral* or *conventual*. *Conventual* are the same as abbots. *Claustral* prior, is he who governs the religious of an abbey or priory in *commendam*, having his jurisdiction wholly from the abbot.

Grand PRIOR, is the superior of a large abbey, where several superiors are required.

PRIOR (Matthew), an eminent English poet, was born at London in 1664. His father dying while he was very young, an uncle a vintner, having given him some education at Westminster school, took him home in order to breed him up to his trade. However, at his leisure hours he prosecuted his study of the classics, and especially of his favourite Horace. This introduced

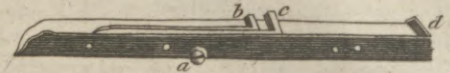
Printing,
Prior.

Strutt's
Dict. of
Engravers.

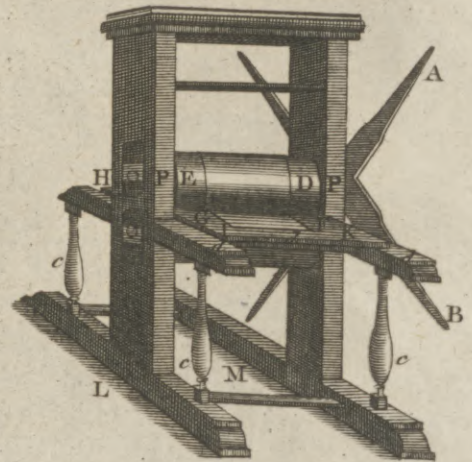
Printing PRESS.



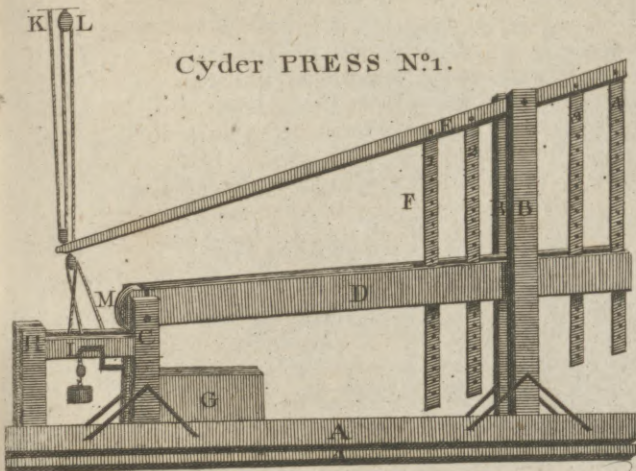
Composing Stick.



Rolling PRESS.



Cyder PRESS N^o.1.



Cyder PRESS N.º 2

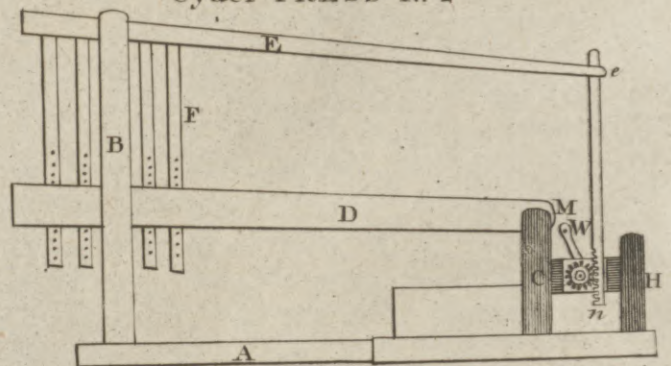


Fig. 4. Potash-kiln.



Fig. 3.

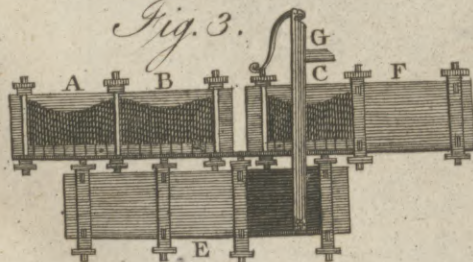
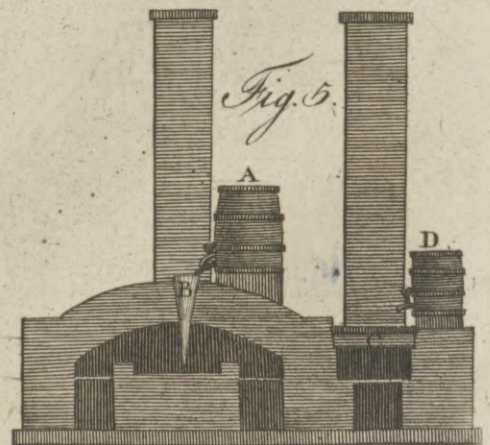


Fig. 5.



Prior. introduced him to some polite company, who frequented his uncle's house; among whom the earl of Dorset took particular notice of him, and procured him to be sent to St John's college in Cambridge, where, in 1686, he took the degree of A. B. and afterwards became fellow of that college. Upon the revolution, Mr Prior was brought to court by the earl of Dorset; and in 1690 he was made secretary to the earl of Berkeley, plenipotentiary at the Hague; as he was afterward to the ambassador and plenipotentiaries at the treaty of Ryfwick in 1697; and the year following to the earl of Portland, ambassador to the court of France. He was in 1697 made secretary of state for Ireland; and in 1700 was appointed one of the lords commissioners of trade and plantations. In 1710, he was supposed to have had a share in writing *The Examiner*. In 1711, he was made one of the commissioners of the customs; and was sent minister plenipotentiary to France, for the negotiating a peace with that kingdom. Soon after the accession of George I. to the throne in 1714, he presented a memorial to the court of France, requiring the demolishing of the canal and new works at Mardyke. The year following he was recalled; and upon his arrival was taken up by a warrant from the house of commons, and strictly examined by a committee of the privy-council. Robert Walpole, Esq; moved the house of commons for an impeachment against him; and Mr Prior was ordered into close custody. In 1717, he was excepted out of the act of grace; however, at the close of that year, he was set at liberty. The remainder of his days he spent in tranquillity and retirement; and died in 1721. His poems are well known, and justly admired. He is said to have written the following epitaph for himself:

" Nobles and heralds, by your leave,
Here lie the bones of Matthew Prior,
The son of Adam and of Eve:
Let Bourbon or Nassau go higher."

Alien PRIORIES, were cells of the religious houses in England which belonged to foreign monasteries: for when manors or tithes were given to foreign convents, the monks, either to increase their own rule, or rather to have faithful stewards of their revenues, built a small convent here for the reception of such a number as they thought proper, and constituted priors over them.—Within these cells there was the same distinction as in those priories which were cells subordinate to some great abbey; some of these were conventual, and, having priors of their own choosing, thereby became entire societies within themselves, and received the revenues belonging to their several houses for their own use and benefit, paying only the ancient apport (A), acknowledgment, or obvention, at first the surplussage, to the foreign house; but others depended entirely on the foreign houses, who appointed and removed their priors at pleasure. These transmitted all their revenues to the foreign head houses; for which reason their estates were generally seized to carry on the wars between

England and France, and restored to them again on return of peace. These alien priories were most of them founded by such as had foreign abbeys founded by themselves or by some of their family.

The whole number is not exactly ascertained; the Monasticon hath given a list of 100: Weever, p. 338, says 110.

Some of these cells were made indigenous or denizen, or endenized. The alien priories were first seized by Edward I. 1285, on the breaking out of the war between France and England; and it appears from a roll, that Edward II. also seized them, though this is not mentioned by our historians; and to these the act of restitution 1 Ed. III. seems to refer.

In 1337, Edward III. confiscated their estates; and let out the priories themselves with all their lands and tenements, at his pleasure, for 23 years; at the end of which term, peace being concluded between the two nations, he restored their estates 1361, as appears by his letters patent to that of Montacute, county of Somerset, printed at large in Rymer, vol. vi. p. 311. and translated in Weever's *Funeral Monuments*, p. 339. At other times he granted their lands, or lay pensions out of them, to divers noblemen. They were also sequestered during Richard II.'s reign, and the head monasteries abroad had the king's licence to sell their lands to other religious houses here, or to any particular persons who wanted to endow others.

Henry IV. began his reign with showing some favour to the alien priories, restoring all the conventual ones, only reserving to himself in time of war what they paid in time of peace to the foreign abbeys.

They were all dissolved by act of parliament 2. Henry V. and all their estates vested in the crown, except some lands granted to the college of Fotheringhay. The act of dissolution is not printed in the statute books, but it is to be found entire in Rymer's *Fœdera*, IX. 283. and in the Parliament Rolls, vol. iv. p. 22. In general, these lands were appropriated to religious uses. Henry VI. endowed his foundations at Eton and Cambridge with the lands of the alien priories, in pursuance of his father's design to appropriate them all to a noble college at Oxford. Others were granted in fee to the prelates, nobility, or private persons. Such as remained in the crown were granted by Henry VI. 1440, to archbishop Chicheley, &c. and they became part of his and the royal foundations. See *Some Account of Alien-Priories*, &c. in two volumes octavo.

PRIORITY, the relation of something considered as prior to another.

PRIORITY, in law, denotes an antiquity of tenure, in comparison of another less ancient.

PRISCIANUS, an eminent grammarian, born at Cæsarea, taught at Constantinople with great reputation about the year 525. Laurentius Valla calls Priscian, Donatus, and Servius, *triumviri in re grammatica*; and thinks none of the ancients who wrote after them fit to be mentioned with them. He composed a work *De arte grammatica*, which was first printed by Aldus at

Prior
||
Priscianus.

(A) *Apportus* or *apportagium* (from *portare*), an acknowledgment, oblation, or obvention, to the mother house or church. *Du Cange*.

Priscillianists
||
Pristis.

at Venice in 1476; and another *De naturalibus questionibus*, which he dedicated to Chosroes king of Persia: beside which, he translated Dionysius's description of the world into Latin verse. A person who writes false Latin, is proverbially said to "break Priscian's head."

PRISCILLIANISTS, in church-history, Christian heretics, so called from their leader Priscillian, a Spaniard by birth, and bishop of Avila. He is said to have practised magic, and to have maintained the principal errors of the Manichees; but his peculiar tenet was, That it is lawful to make false oaths in order to support one's cause and interests.

PRISM, an oblong solid, contained under more than four planes, whose bases are equal, parallel, and alike situated. See OPTICS, n° 142.

PRISON, a gaol, or place of confinement.

Lord Coke observes, that a prison is only a place of safe custody, *salva custodia*, not a place of punishment. If this be so, and it cannot be questioned, prisons ought not to be, what they are in most parts of Europe, loathsome dungeons. Any place where a person is confined may be said to be a prison; and when a process is issued against one, he must, when arrested thereon, either be committed to prison, or be bound in a recognizance with sureties, or else give bail, according to the nature of the case, to appear at a certain day in court, there to make answer to what is alleged against him. Where a person is taken and sent to prison, in a civil case, he may be released by the plaintiff in the suit; but if it be for treason or felony, he may not regularly be discharged, until he is indicted of the fact and acquitted. See INDICTMENT, and the next article.

PRISONER, a person restrained or kept in prison upon an action civil or criminal, or upon commendment: and one may be a prisoner on matter of record or matter of fact. A prisoner upon matter of record, is he who, being present in court, is by the court committed to prison; and the other is one carried to prison upon an arrest, whether it be by the sheriff, constable, or other officer.

PRISTIS, the SAWFISH, is generally considered as a species of the *squalus* or *shark* genus, comprehending under it several varieties. Mr Latham, however, is of opinion that it ought to be considered as a distinct genus itself, and that the characteristics of the several varieties are sufficient to constitute them distinct species. According to him therefore the *pristis* is a genus belonging to the order of *amphibia nantes*; and its characters are as follow: A long plane beak or snout, with spines growing like teeth out of both edges; four or five *spiracula*, or breathing apertures, in the sides of the neck: the body is oblong and almost round, with a rough coriaceous skin; the mouth is situated in the lower part of the head; and the nostrils, before the mouth, are half covered with a membranaceous lobe; behind the eyes are two oval holes; the ventral fins approach one another, and in the male are placed about the organs of generation; there are no fins at the anus. Of this genus our author enumerates five species.

1. *Pristis antiquorum*. The head is rather flat at top; the eyes large, with yellow irides; behind each is a hole, which some have supposed may lead to an organ of hearing. The mouth is well furnished with teeth,

but they are blunt, serving rather to bruise its prey than to divide it by cutting. Before the mouth are two foramina, supposed to be the nostrils. The *rostrum*, beak, or snout, is in general about one-third of the total length of the fish, and contains in some 18, in others as far as 23 or 24 spines on each side; these are very stout, much thicker at the back-part, and channelled, inclining to an edge forwards. The fins are seven in number—viz. two dorsal, placed at some distance from each other—two pectoral, taking rise just behind the breathing-holes, which are five in number—two ventral, situated almost underneath the first dorsal—and lastly the caudal, occupying the tail both above and beneath, but longest on the upper part. The general colour of the body is a dull grey, or brownish, growing paler as it approaches the belly, where it is nearly white. 2. *Pectinatus*, which, with the former species, grows to the largest size of any that have yet come under the inspection of the naturalist, some specimens measuring 15 feet in length. The pectinatus differs from the pristis antiquorum, in having the snout more narrow in proportion at the base, and the whole of it more slender in all its parts; whereas the first is very broad at the base, and tapers considerably from thence to the point. The spines on each side also are longer and more slender, and vary from 25 to 34 in the different specimens: we have indeed been informed of one which contained no less than 36 spines on each side of the snout; but we must confess that we have never been fortunate enough to have seen such a specimen. 3. *Cuspidatus*, of which our author has seen only two specimens, the one about a foot and a half in length, and the other more than two feet and a half. In both of these were 28 spines on each side; but the distinguishing feature is in the spines themselves, being particularly flat and broad, and shaped at the point more like the lancet used by surgeons in bleeding, than any other figure. We believe that no other author has hitherto taken notice of this species. 4. *Microdon*, of which the total length is 28 inches, the snout occupying 10; from the base of this to that of the pectoral fins four inches; between the pectoral and ventral fins six. The two dorsal fins occupy nearly the same proportions in respect to each other; but the hinder one is the smallest, and all of them are greatly hollowed out at the back-part, much more so than in the two first species. The snout differs from that of every other, in several particulars: it is longer in proportion, being more than one-third of the whole fish. The spines do not stand out from the sides more than a quarter of an inch, and from this circumstance seem far less capable of doing injury than any other species yet known. 5. *Cirratus*, of which, continues our author, we have only met with one specimen, which was brought from Port Jackson in New Holland. It is a male, and the total length about 40 inches: the snout, from the tip of it to the eye, 11: the spines widely different from any of the others; they are indeed placed, as usual, on the edge, but are continued on each side even beyond the eyes. The longer ones are slender, sharp, somewhat bent, and about 20 in number; and between these are others not half the length of the primal ones, between some three or four, between others as far as six; and in general the middle one of these smaller series is the longest: beside these a series

Prist's.

Privateers series of minute ones may be perceived beneath, at the very edge. In the snout likewise another singularity occurs:—about the middle of it, on each side, near the edge, arises a flexible, ligamentous cord, about three inches and a half in length, appearing not unlike the beards at the mouth of some of the gadus or cod genus, and no doubt as pliant in the recent state. The colour of the fish is a pale brown: the breathing apertures four in number: the mouth furnished with five rows of minute, but very sharp teeth. See Plate CCCCXVI. where the snout marked 1 is that of the *pristis antiquorum*; that marked 2, of *pestinatus*; and that marked 4, of *microdon*: the entire fish is the *circatus*.

PRIVATEERS, are a kind of private men of war, the persons concerned wherein administer at their own costs a part of a war, by fitting out these ships of force, and providing them with all military stores; and they have, instead of pay, leave to keep what they take from the enemy, allowing the admiral his share, &c.

Privateers may not attempt any thing against the laws of nations; as to assault an enemy in a port or haven, under the protection of any prince or republic, whether he be friend, ally, or neuter; for the peace of such places must be inviolably kept: therefore, by a treaty made by King William and the States of Holland, before a commission shall be granted to any privateer, the commander is to give security, if the ship be not above 150 tons, in L. 1500, and if the ship exceeds that burden, in L. 3000, that they will make satisfaction, for all damages which they shall commit in their courses at sea, contrary to the treaties with that state, on pain of forfeiting their commissions; and the ship is made liable.

Besides these private commissions, there are special commissions for privateers, granted to commanders of ships, &c. who take pay; who are under a marine discipline; and if they do not obey their orders, may be punished with death: and the wars in later ages have given occasion to princes to issue these commissions, to annoy the enemies in their commerce, and hinder such supplies as might strengthen them or lengthen out the war; and likewise to prevent the separation of ships of greater force from their fleets or squadrons.

Ships taken by privateers were to be divided into five parts; four parts whereof to go to the persons interested in the privateer, and the fifth to his Majesty: and as a farther encouragement, privateers, &c. destroying any French man of war or privateer, shall receive, for every piece of ordnance in the ship so taken, L. 10 reward, &c.

By a particular statute lately made, the lord admiral, or commissioners of the admiralty, may grant commissions to commanders of privateers, for taking ships, &c. which being adjudged prize, and the tenth part paid to the admiral, &c. wholly belong to the owners of the privateers and the captors, in proportions agreed on between themselves.

PRIVATION, in a general sense, denotes the absence or want of something; in which sense darkness is only the privation of light.

PRIVATIVE, in grammar, a particle, which, prefixed to a word, changes it into a contrary sense. Thus,
VOL. XV. Part II.

among the Greeks, the α is used as a privative; as in $\alpha\text{-}\beta\iota\omicron\varsigma$, *atheist*, *acephalus*, &c.—The Latins have their privative *in*; as, *in corrigibilis*, *indeclinabilis*, &c.—The English, French, &c. on occasion borrow both the Latin and Greek privatives.

PRIVERNUM, (Livy, Virgil); a town of the Volsci, in Latium, to the east of Setia. *Privernates*, the people. Whose ambassadors being asked, What punishment they deserved for their revolt? answered, What those deserve who deem themselves worthy of liberty. And again, being asked by the Roman consul, should the punishment be remitted, What peace was to be expected with them? If you grant a good peace, you may hope to have it sincere and lasting; but if a bad one, you may well expect it of short continuance. At which answer, the Romans were so far from being displeased, that by a vote of the people they had the freedom of the city granted them. *Privernas*, *atis*, the epithet. The town is now called *Piperno Vecchio*, situated in the Campania of Rome. E. Long. 10. 0. N. Lat. 41. 30.

PRIVET, in botany. See **LIGUSTRUM**.

PRIVILEGE, in law, some peculiar benefit granted to certain persons or places, contrary to the usual course of the law.

Privileges are said to be *personal* or *real*.

Personal privileges are such as are extended to peers, ambassadors, members of parliament, and of the convocation, &c. See **LORDS**, **AMBASSADOR**, **PARLIAMENT**, **ARREST**, &c.

A *real* privilege is that granted to some particular place; as the king's palace, the courts at Westminster, the universities, &c.

PRIVILEGES of the Clergy. See **CLERGY**.

PRIVY, in law, is a partaker, or person having an interest, in any action or thing. In this sense they say, privies in blood: every heir in tail is privy to recover the land intailed. In old law-books, merchants privy are opposed to merchants strangers. Coke mentions four kinds of privies. Privies in blood, as the heir to his father; privies in representation, as executors and administrators to the deceased; privies in estate, as he in reversion, and he in remainder donor and donee; lessor and lessee: lastly, privy in tenure, as the lord by escheat; *i.e.* when land escheats to the lord for want of heirs.

PRIVY-Council. See **COUNCIL**. The king's will is the sole constituent of a privy counsellor; and it also regulates their number, which in ancient times was about twelve. Afterwards it increased to so large a number, that it was found inconvenient for secrecy and dispatch; and therefore Charles II. in 1679, limited it to 30; whereof 15 were principal officers of state, and to be counsellors *ex officio*; and the other 15 were composed of 10 lords and five commoners of the king's choosing. Since that time however the number has been much augmented, and now continues indefinite. At the same time also, the ancient office of lord president of the council was revived, in the person of Anthony earl of Shaftesbury. Privy-counsellors are made by the king's nomination, without either patent or grant; and, on taking the necessary oaths, they become immediately privy-counsellors during the life of the king that chooses them, but subject to removal at his discretion.

Privy.

Any natural born subject of England is capable of being a member of the privy-council; taking the proper oaths for security of the government, and the test for security of the church. By the act of settlement, 12 and 13 W. III. cap. 2. it is enacted, that no person born out of the dominions of the crown of England, unless born of English parents, even though naturalized by parliament, shall be capable of being of the privy-council. The duty of a privy-counsellor appears from the oath of office, which consists of seven articles. 1. To advise the king according to the best of his cunning and discretion. 2. To advise for the king's honour and good of the public, without partiality, through affection, love, need, doubt, or dread. 3. To keep the king's counsel secret. 4. To avoid corruption. 5. To help and strengthen the execution of what shall be there resolved. 6. To withstand all persons who would attempt the contrary. And, lastly, in general, 7. To observe, keep, and do all that a good and true counsellor ought to do to his sovereign lord.

The privy-council is the *primum mobile* of the state, and that which gives the motion and direction to all the inferior parts. It is likewise a court of justice of great antiquity; the primitive and ordinary way of government in England being by the king and privy-council. It has been frequently used by all our kings for determining controversies of great importance: the ordinary judges have sometimes declined giving judgment till they had consulted the king and privy-council; and the parliament have frequently referred matters of high moment to the same, as being by long experience better able to judge of, and, by their secrecy and expedition, to transact some state affairs, than the lords and commons. At present, the privy-council takes cognizance of few or no matters except such as cannot well be determined by the known laws and ordinary courts; such as matters of complaint and sudden emergencies: their constant business being to consult for the public good in affairs of state. This power of the privy-council is to inquire into all offences against the government, and to commit the offenders to safe custody, in order to take their trial in some of the courts of law. But their jurisdiction herein is only to inquire, and not to punish; and the persons committed by them are intitled to their *habeas corpus* by statute 16 Car. I. cap. 10. as much as if committed by an ordinary justice of the peace.

In plantation or admiralty causes, which arise out of the jurisdiction of this kingdom, and in matters of lunacy and idiocy, the privy-council has cognizance, even in questions of extensive property, being the court of appeal in such causes; or, rather, the appeal lies to the king's majesty himself in council. From all the dominions of the crown, excepting Great Britain and Ireland, an appellate jurisdiction (in the last resort) is vested in this tribunal; which usually exercises its judicial authority in a committee of the whole privy-council, who hear the allegations and proofs, and make their report to his majesty in council, by whom the judgment is finally given.

Anciently, to strike in the house of a privy-counsellor, or elsewhere in his presence, was grievously punished: by 3 Hen. VII. cap. 14. if any of the king's servants of his household conspire or imagine to take away the life of a privy-counsellor, it is felony, though

nothing shall be done upon it; and by 9 Ann. cap. 16. it is enacted, that any persons who shall unlawfully attempt to kill, or shall unlawfully assault, and strike, or wound, any privy-counsellor in the execution of his office, shall be felons, and suffer death as such. With advice of this council, the king issues proclamations that bind the subject, provided they be not contrary to law. In debates, the lowest delivers his opinion first, the king last; and thereby determines the matter. A council is never held without the presence of a secretary of state.

The dissolution of the privy-council depends upon the king's pleasure; and he may, whenever he thinks proper, discharge any particular member, or the whole of it, and appoint another. By the common law also it was dissolved *ipso facto* by the king's demise, as deriving all its authority from him. But now, to prevent the inconveniences of having no council in being at the accession of a new prince, it is enacted, by 6 Ann. cap. 7. that the privy-council shall continue for six months after the demise of the crown, unless sooner determined by the successor. *Blackst. Com. book i. p. 229, &c.*

The officers of the privy-council are four clerks of the council in ordinary, three clerks extraordinary, a keeper of the records, and two keepers of the council-chamber. See PRESIDENT,

Privy Seal, a seal which the king uses previously to such grants, &c. as are afterwards to pass the great seal.

The privy seal is also sometimes used in matters of less consequence, which do not require the great seal.

Lord Privy Seal. See *KEEPER of the Privy Seal*.

Clerks of the Privy Seal. See *CLERK*.

Privy Chamber. See *CHAMBER*.

PRIZE, or PRISE, in maritime affairs, a vessel taken at sea from the enemies of a state, or from pirates; and that either by a man of war, a privateer, &c. having a commission for that purpose.

Vessels are looked on as prize, if they fight under any other standard than that of the state from which they have their commission; if they have no charter-party, invoice, or bill of lading aboard; if loaded with effects belonging to the king's enemies, or with contraband goods.

In ships of war, the prizes are to be divided among the officers, seamen, &c. as his Majesty shall appoint by proclamation; but among privateers, the division is according to the agreement between the owners.

By stat. 13 Geo. II. c. 4. judges and officers, failing of their duty in respect to the condemnation of prizes, forfeit L. 500, with full costs of suit; one moiety to the king, and the other to the informer.

PROA, FLYING, in navigation, is a name given to a vessel used in the south seas, because with a brisk trade-wind it sails near 20 miles an hour. In the construction of the proa, the head and stern are exactly alike, but the sides are very different; the side intended to be always the lee-side being flat; and the windward side made rounding, in the manner of other vessels; and, to prevent her over-setting, which from her small breadth, and the straight run of her leeward side, would, without this precaution, infallibly happen, there is a frame laid out to her from windward, to the end of which is fastened a log, fashioned into the shape of a small boat, and made hollow. The weight of the frame

Privy.
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Proa.

Probabi-
lity.

frame is intended to balance the proa, and the small boat is by its buoyancy (as it is always in the water) to prevent her oversetting to windward; and this frame is usually called an outrigger. The body of the vessel is made of two pieces joined endwise, and sewed together with bark, for there is no iron used about her; she is about two inches thick at the bottom, which, at the gunwale, is reduced to less than one. The sail is made of matting, and the mast, yard, boom, and outriggers, are all made of bamboo. See *Anson's Voyage*, quarto, p. 347.

PROBABILITY is a word of nearly the same import with likelihood. It denotes the appearance of truth, or that evidence arising from the preponderation of argument which produces opinion. (See OPINION.) Locke classes all arguments under the heads of *demonstrative* and *probable*: Hume with greater accuracy divides them into *demonstrations*, *proofs*, and *probabilities*. Demonstration produces *science*; proof, *belief*; and probability, *opinion*.

Hardly any thing is susceptible of strict demonstration besides the mathematical sciences, and a few propositions in metaphysical theology. Physics rest upon principles capable, some of them, of complete proof by experience, and others of nothing more than probability by analogical reasoning. What has *uniformly* happened, we expect with the fullest confidence to happen again in similar circumstances; what has *frequently* happened, we likewise expect to happen again; but our expectation is not confident. Uniform experience is proof; frequent experience is probability. The strongest man has *always* been able to lift the greatest weight; and, therefore, knowing that one man is stronger than another, we expect, with confidence, that the former will lift more than the latter. The best disciplined army has *generally* proved victorious, when all other circumstances were equal. We therefore expect that an army of veterans will, upon fair ground, defeat an equal number of new levied troops: but as sudden panics have sometimes seized the oldest soldiers, this expectation is accompanied with doubt, and the utmost that we can say of the expected event is, that it is *probable*; whereas in the competition between the two men, we look upon it as *morally certain*. (See METAPHYSICS, part I. chap. vii. sec. 3.) When two or three persons of known veracity attest the same thing as consistent with their knowledge, their testimony amounts to *proof*, if not contradicted by the testimony of others; if contradicted, it can, at the utmost, amount only to probability. In common language we talk of *circumstantial* proofs and *presumptive* proofs; but the expressions are improper, for such evidence amounts to nothing more than probability. Of probability there are indeed various degrees from the confines of certainty down to the confines of impossibility; and a variety of circumstances tending to the same point, though they amount not to what, in strictness of language, should be called *proof*, afford to the mind a very high degree of evidence, upon which, with the addition of one direct testimony, the laws of many countries take away the life of a man.

PROBABILITY of an Event, in the *Doctrine of Chances*, is greater or less according to the number of chances by which it may happen or fail. (See EXPECTATION.) The probability of life is liable to rules of computation. In the *Encyclopédie Methodique*, we find a table of the

probabilities of the duration of life, constructed from that which is to be found in the seventh volume of the *Supplément à l'Histoire de M. de Buffon*; of which the following is an abridgement.

Probats
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Probability.

Of 23,994 children born at the same time, there will probably die

$\frac{1}{2}$	In one year	-	7998
$\frac{1}{3}$	Remaining $\frac{2}{3}$ or 15996	-	
$\frac{1}{4}$	In eight years	-	11997
$\frac{1}{5}$	Remaining $\frac{4}{5}$ or 11997	-	
$\frac{1}{6}$	In thirty eight years	-	15996
$\frac{1}{7}$	Remaining $\frac{6}{7}$ or 7998	-	
$\frac{1}{8}$	In fifty years	-	17994
$\frac{1}{9}$	Remaining $\frac{8}{9}$ or 5998	-	
$\frac{1}{10}$	In sixty one years	-	19995
$\frac{1}{11}$	Remaining $\frac{10}{11}$ or 3999	-	
$\frac{1}{12}$	In seventy years	-	21595
$\frac{1}{13}$	Remaining $\frac{12}{13}$ or 2399	-	
$\frac{1}{14}$	In eighty years	-	22395
$\frac{1}{15}$	Remaining $\frac{14}{15}$ or 599	-	
$\frac{1}{16}$	In ninety years	-	23914
$\frac{1}{17}$	Remaining $\frac{16}{17}$ or 80	-	
$\frac{1}{18}$	In an hundred years	-	23992
	Remaining $\frac{17}{18}$ or 2.	-	See Bills of MORTA-

LITY.

PROBATE of a will or testament, in law, is the exhibiting and proving of last wills and testaments before the ecclesiastical judge delegated by the bishop, who is ordinary of the place where the party died.

PROBATION, in the universities, is the examination and trial of a student who is about to take his degrees.

PROBATION, in a monastic sense, signifies the year of a novitiate, which a religious must pass in a convent, to prove his virtue and vocation, and whether he can bear the severities of the rule.

PROBATION, in Scots law. See LAW, p. 714.

PROBATIONER, in the church of Scotland, a student in divinity, who bringing a certificate from a professor in an university of his good morals, and his having performed his exercises to approbation, is admitted to undergo several trials; and, upon his acquitting himself properly in these, receives a licence to preach.

PROBATUM EST (*It is proved*), a term frequently subjoined to a receipt for the cure of some disease.

PROBE, a surgeon's instrument for examining the circumstances of wounds, ulcers, and other cavities, searching for stones in the bladder, &c.

PROBITY means honesty, sincerity, or veracity; and consists in the habit of actions useful to society, and in the constant observance of the laws which justice and conscience impose on us. The man who obeys all the laws of society with an exact punctuality is not therefore a man of probity; laws can only respect the external and definite parts of human conduct, but probity respects our more private actions, and such as it is impossible in all cases to define; and it appears to be in morals what charity is in religion. Probity teaches us to perform in society those actions which no external power can oblige us to perform, and is that quality in the human mind from which we claim the performance of the rights commonly called *imperfect*. See MORAL PHILOSOPHY.

Problem **PROBLEM**, in logic, is a proposition that neither appears absolutely true nor false; and, consequently, may be asserted either in the affirmative or negative.

Procellaria.

PROBLEM, in geometry, is a proposition, wherein some operation or construction is required; as to divide a line or angle, erect or let fall perpendiculars, &c. See **GEOMETRY**.

PROBOSCIS, in natural history, is the trunk or snout of an elephant, and some other animals and insects.

Flies, gnats, &c. are furnished with a proboscis or trunk; by means of which they suck the blood of animals, the juice of vegetables, &c. for their food.

PROBUS (Marcus Aurelius), from the son of a gardener, became, by his great valour as a soldier, and his eminent virtues, emperor of Rome, to which dignity he was raised by the army. After having subdued the barbarous nations that had made incursions into different parts of the empire, where they committed horrid cruelties, and governed with great wisdom and clemency, he was massacred in the 7th year of his reign, by some soldiers who were weary of the public works at which he made them labour, in 282.

PROCATARCTIC CAUSE, in medicine, the pre-existing, or predisposing cause or occasion of a disease.

PROCELEUSMATICUS, in the ancient poetry, a foot consisting of four short syllables, or two pyrrhiciuses; as *hominibus*.

PROCELLARIA, in ornithology; a genus of birds, belonging to the order of anseres. The beak is somewhat compressed; and without teeth; the mandibles are equal, the superior one being crooked at the point; the feet are palmated, the hind claw being sessile, without any toe. Mr Latham (See his *Index Ornithologicus*, p. 820.) enumerates 24 species, which are principally distinguished by their colour. The most remarkable are,

1. The cinerea, or petrel. The size of this bird is rather superior to that of the common gull: the bill very strong, much hooked at the end, and of a yellow colour. The nostrils are composed of two large tubes, lodged in one sheath: the head, neck, whole under side of the body, and tail, are white: the back and coverts of the wings ash-coloured: the quill-feathers dusky: and the legs yellowish. In lieu of a back toe, it has only a sort of spur, or sharp straight nail. These birds feed on the blubber or fat of whales, &c. which being soon convertible into oil, supplies them constantly with means of defence, as well as provision for their young, which they cast up into their mouths. They are likewise said to feed on sorrel, which they use to qualify the unctuous diet they live on. This species inhabits the isle of St Kilda; makes its appearance there in November, and continues the whole year, except September and October; it lays a large, white, and very brittle egg; and the young are hatched the middle of June. No bird is of such use to the islanders as this: the fulmar supplies them with oil for their lamps, down for their beds, a delicacy for their tables, a balm for their wounds, and a medicine for their distempers. The fulmar is also a certain prognosticator of the change of the wind: if it comes to land, no west wind is expected for some time; and the contrary when it returns and keeps the sea. The whole genus of petrels have a peculiar faculty of spouting from their bills, to a considerable distance,

a large quantity of pure oil; which they do, by way of defence, into the face of any one that attempts to take them: so that they are, for the sake of this panacea, seized by surprise; as this oil is subservient to the above-mentioned medical purposes. Martin tells us, it has been used in London and Edinburgh with success in rheumatic cases. Frederick Martens, who had opportunity of seeing vast numbers of these birds at Spitzbergen, observes, that they are very bold, and resort after the whale-fishers in great flocks; and that, when a whale is taken, they will, in spite of all endeavours, light on it and pick out large lumps of fat, even when the animal is alive: That the whales are often discovered at sea by the multitudes of them flying; and that when one of the former are wounded, prodigious multitudes immediately follow its bloody track. He adds, that it is a most gluttonous bird, eating till it is forced to disgorge itself.

2. The puffinus, or shear-water, is 15 inches in length; the breadth 31; the weight 17 ounces: the bill is an inch and three quarters long; nostrils tubular, but not very prominent: the head, and whole upper side of the body, wings, tail, and thighs, are of a sooty blackness; the under side from chin to tail, and inner coverts of the wings, white: the legs weak, and compressed sidewise; dusky behind, whitish before. These birds are found in the Calf of Man; and, as Mr Ray supposes, in the Scilly isles. They resort to the former in February; take a short possession of the rabbit-burrows, and then disappear till April. They lay one egg, white and blunt at each end; and the young are fit to be taken the beginning of August; when great numbers are killed by the person who farms the isle: they are salted and barrelled; and when they are boiled, are eaten with potatoes. During the day they keep at sea, fishing; and towards evening return to their young; whom they feed, by discharging the contents of their stomachs into their mouths; which by that time is turned into oil: by reason of the backward situation of their legs, they sit quite erect. They quit the isle the latter end of August, or beginning of September; and, from accounts lately received from navigators, we have reason to imagine that, like the storm-finch, they are dispersed over the whole Atlantic ocean. This species inhabits also the Orkney isles, where it makes its nest in holes on the earth near the shelves of the rocks and headlands: it is called there the *lyre*; and is much valued, both on account of its being a food, and for its feathers. The inhabitants take and salt them in August for winter provisions, when they boil them with cabbage. They also take the old ones in March; but they are then poor, and not so well tasted as the young: they appear first in those islands in February.

3. The pelagica, or stormy petrel, is about the bulk of the house-swallow: the length six inches; the extent of wings, 13. The whole bird is black, except the coverts of the tail and vent-feathers, which are white: the bill is hooked at the end: the nostrils tubular: the legs slender, and long. It has the same faculty of spouting oil from its bill as the other species: and Mr Brunnich tells us, that the inhabitants of the Ferroe isles make this bird serve the purposes of a candle, by drawing a wick through the mouth and rump, which being lighted, the flame is fed by the fat and oil of the body. Except in breeding-time, it is always at sea; and is seen all over the vast Atlantic ocean, at the greatest distance

Procellaria
Process.

distance from land; often following the vessels in great flocks, to pick up any thing that falls from on board: for trial sake, chopped straw has been flung over, which they would stand on with expanded wings; but were never observed to settle on or swim in the water: it presages bad weather, and cautions the seamen of the approach of a tempest, by collecting under the stern of the ships: it braves the utmost fury of the storm, sometimes skimming with incredible velocity along the hollows of the waves, sometimes on the summits: Clusius makes it the Camilla of the sea.

*Vel mare per medium fluctu suspensa tument
Ferret iter, celeres nec tingeret aquore plantas.* VIRG.

She swept the seas; and, as she skimm'd along,
Her flying feet unbath'd on billows hung. DRYDEN.

These birds are the *cypseli* of Pliny, which he places among the *apodes* of Aristotle; not because they wanted feet, but were *κακοποδα*, or had bad or useless ones; an attribute he gives to these species, on a supposition that they were almost always on the wing. In August 1772, Mr Pennant found them on the rocks called *Macdonald's Table*, off the north end of the isle of Skie; so conjectures they breed there. They lurked under the loose stones, but betrayed themselves by their twittering noise.

In Mr White's *Journal of a Voyage to New South Wales* we have a figure of the fuliginous petrel, with a whitish beak; which he takes to be a variety of the *Procellaria Equinoctialis* of Linnæus. It is nearly of the size of a raven; its colour is a deep sooty brown or blackish; on the chin there is a small patch of white running down a little on each side from the lower mandible; the beak is of yellowish white. See Plate CCCCXVI. Captain Bligh, in his *Voyage to the South Seas*, in S. Lat. 60. 1. and W. Long. 71. 45. saw both petrels and pintadas; some of which he took with baited hooks.

PROCESS, in law, denotes the proceedings in any cause, real or personal, civil or criminal, from the original writ to the end thereof.

In a more limited sense, process denotes that by which a man is called first into any temporal court.

It is the next step for carrying on the suit, after suing out the original writ. See *Suit* and *Writ*.

It is the method taken by the law to compel a compliance with the original writ, of which the primary step is by giving the party notice to obey it. This notice is given upon all real *precipes*; and also upon all personal writs for injuries not against the peace, by *summons*; which is a warning to appear in court at the return of the original writ, given to the defendant by two of the sheriff's messengers called *summoners*, either in person, or left at his house or land: in like manner as in the civil law the first process is by personal citation, *in jus vocando*. This warning on the land is given, in real actions, by erecting a white stick or wand on the defendant's grounds (which stick or wand among the northern nations is called the *baculus nunciatorius*), and by statute 31 Eliz. c. 3. the notice must also be proclaimed on some Sunday before the door of the parish church.

If the defendant disobey this verbal monition, the next process is by writ of *attachment*, or *pone*; so called from the words of the writ, *pone per vadium et salvos plegios*, "put by gage and safe pledges A. B. the de-

fendant," &c. This is a writ not issuing out of chancery, but out of the court of common-pleas, being grounded on the non-appearance of the defendant at the return of the original writ; and thereby the sheriff is commanded to attach him, by taking *gage*, that is, certain of his goods, which he shall forfeit if he doth not appear; or by making him find *safe pledges* or sureties, which shall be amerced in case of his non-appearance. This is also the first and immediate process, without any previous summons, upon actions of trespass *vi et armis*, or for other injuries, which, though not forcible, are yet trespasses against the peace, as *deceit* and *conspiracy*; where the violence of the wrong requires a more speedy remedy, and therefore the original writ commands the defendant to be at once attached, without any precedent warning.

If, after attachment, the defendant neglects to appear, he not only forfeits this security, but is moreover to be farther compelled by writ of *distingas*, or distress infinite: which is a subsequent process issuing from the court of common-pleas, commanding the sheriff to distress the defendant from time to time, and continually afterwards, by taking his goods and the profits of his lands, which are called *issues*, and which he forfeits to the king if he doth not appear. But the issues may be sold, if the court shall so direct, in order to defray the reasonable costs of the plaintiff. In like manner, by the civil law, if the defendant absconds, so that the citation is of no effect, *mittitur adversarius in possessionem bonorum ejus*.

And here, by the common as well as the civil law, the process ended in case of injuries without force: the defendant if he had any substance, being gradually stripped of it all by repeated distresses, till he rendered obedience to the king's writ; and, if he had no substance, the law held him incapable of making satisfaction, and therefore looked upon all farther process as nugatory. And besides, upon feudal principles, the person of a feudatory was not liable to be attached for injuries merely civil, lest thereby his lord should be deprived of his personal services. But, in cases of injury accompanied with force, the law, to punish the breach of the peace and prevent its disturbance for the future, provided also a process against the defendant's person, in case he neglected to appear upon the former process of attachment, or had no substance whereby to be attached; subjecting his body to imprisonment by the writ of *capias ad respondendum*. But this immunity of the defendant's person, in case of peaceable though fraudulent injuries, producing great contempt of the law in indigent wrongdoers, a *capias* was also allowed, to arrest the person in actions of account, though no breach of the peace be suggested, by the statutes of Marlbridge, 52 Hen. III. c. 23. and Westm. 2. 13 Edw. I. c. 11. in actions of debt and detainue, by statute 25 Edw. III. c. 17. and in all actions on the case, by statute 19 Hen. VII. c. 9. Before which last statute a practice had been introduced of commencing the suit by bringing an original writ of trespass *quare clausum fregit*, by breaking the plaintiff's close, *vi et armis*; which by the old common law subjected the defendant's person to be arrested by writ of *capias*: and then afterwards, by connivance of the court, the plaintiff might proceed to prosecute for any other less forcible injury. This practice (through custom rather than necessity, and for saving some trouble and expence,

Process.

Blackst.
Comment.

Process

pence, in suing out a special original adapted to the particular injury) still continues in almost all cases, except in actions of debt; though now, by virtue of the statutes above cited and others, a *capias* might be had upon almost every species of complaint.

If therefore the defendant, being summoned or attached, makes default, and neglects to appear; or if the sheriff returns a *nihil*, or that the defendant hath nothing whereby he may be summoned, attached, or distrained, the *capias* now usually issues: being a writ commanding the sheriff to take the body of the defendant, if he may be found in his bailiwick or county, and him safely to keep, so that he may have him in court on the day of the return, to answer to the plaintiff of a plea of debt, or trespass, &c. as the case may be. This writ, and all others subsequent to the original writ, not issuing out of chancery, but from the court into which the original was returnable, and being grounded on what has passed in that court in consequence of the sheriff's return, are called *judicial*, not *original*, writs; they issue under the private seal of that court, and not under the great seal of England; and are *tested*, not in the king's name, but in that of the chief justice only. And these several writs being grounded on the sheriff's return, must respectively bear date the same day on which the writ immediately preceding was returnable.

This is the regular and orderly method of process. But it is now usual in practice to sue out the *capias* in the first instance, upon a supposed return of the sheriff; especially if it be suspected that the defendant, upon notice of the action, will abscond; and afterwards a fictitious original is drawn up, with a proper return thereupon, in order to give the proceedings a colour of regularity. When this *capias* is delivered to the sheriff, he by his under-sheriff grants a warrant to his inferior officers or bailiffs to execute it on the defendant. And, if the sheriff of Oxfordshire (in which county the injury is supposed to be committed and the action is laid) cannot find the defendant in his jurisdiction, he returns that he is not found, *non est inventus*, in his bailiwick: whereupon another writ issues, called a *testatum capias*, directed to the sheriff of the county where the defendant is supposed to reside, as of Berkshire, reciting the former writ, and that it is testified, *testatum est*, that the defendant lurks or wanders in his bailiwick, where he is commanded to take him, as in the former *capias*. But here also, when the action is brought in one county and the defendant lives in another, it is usual, for saving trouble, time, and expence, to make out a *testatum capias* at the first; supposing not only an original, but also a former *capias*, to have been granted; which in fact never was. And this fiction, being beneficial to all parties, is readily acquiesced in, and is now become the settled practice; being one among many instances to illustrate that maxim of law, that *in fictione juris confilii equitas*.

But where a defendant absconds, and the plaintiff would proceed to an outlawry against him, an original writ must then be sued out regularly, and after that a *capias*. And if the sheriff cannot find the defendant upon the first writ of *capias*, and returns a *non est inventus*, there issues out an *alias* writ, and after that a *pluries*, to the same effect as the former: only after these words "we command you," this clause is inserted, "as we have formerly," or, "as we have often commanded you;"—

Process

"*sicut alias*," or, "*sicut pluries, precepimus*." And if a *non est inventus* is returned upon all of them, then a writ of *exigent* or *exigi facias* may be sued out, which requires the sheriff to cause the defendant to be proclaimed, required, or exacted, in five county-courts successively, to render himself; and if he does, then to take him, as in a *capias*: but if he does not appear, and is returned *quinto exactus*, he shall then be outlawed by the coroners of the county. Also by statute 6 Hen. VIII. c. 4. and 31 Eliz. c. 3. whether the defendant dwells within the same or another county than that wherein the *exigent* is sued out, a writ of proclamation shall issue out at the same time with the *exigent*, commanding the sheriff of the county, wherein the defendant dwells, to make three proclamations thereof in places the most notorious, and most likely to come to his knowledge, a month before the outlawry shall take place. Such outlawry is putting a man out of the protection of the law, so that he is incapable to bring an action for redress of injuries; and it is also attended with a forfeiture of all one's goods and chattels to the king. And therefore, till some time after the conquest, no man could be outlawed but for felony: but in Bracton's time, and somewhat earlier, process of outlawry was ordained to lie in all actions for trespasses *vi et armis*. And since, by a variety of statutes (the same which allow the writ of *capias* before-mentioned) process of outlawry doth lie in divers actions that are merely civil; providing they be commenced by original and not by bill. If after outlawry the defendant appears publicly, he may be arrested by a writ of *capias utlagatum*, and committed till the outlawry be reversed. Which reversal may be had by the defendant's appearing personally in court (and in the king's bench without any personal appearance, so that he appears by attorney, according to statute 4 & 5 W. & M. c. 18.) and any plausible cause, however slight, will in general be sufficient to reverse it, it being considered only as a process to compel an appearance. But then the defendant must pay full costs, and put the plaintiff in the same condition as if he had appeared before the writ of *exigi facias* was awarded.

Such is the first process in the court of common pleas. In the king's bench they may also (and frequently do) proceed in certain causes, particularly in actions of ejectment and trespass, by original writ, with *attornment* and *capias* thereon; returnable, not at Westminster, where the common pleas are now fixed in consequence of *magna charta*, but *ubicunque fuerimus in Anglia*, whosoever the king shall then be in England; the king's bench being removeable into any part of England at the pleasure and discretion of the crown. But the more usual method of proceeding therein is without any original, but by a peculiar species of process intitled a *bill of Middlesex*; and therefore so intitled, because the court now sits in that county; for if it sat in Kent, it would then be a bill of Kent. For though, as the justices of this court have, by its fundamental constitution, power to determine all offences and trespasses, by the common law and custom of the realm, it needed no original writ from the crown to give it cognizance of any misdemeanour in the county wherein it resides; yet as, by this court's coming into any county, it immediately superseded the ordinary administration of justice by the general commissions of *eyre* and of *oyer and terminer*, a process of its own became necessary, within the county where

Process.

it sat, to bring in such persons as were accused of committing any forcible injury. The bill of Middlesex (which was formerly always founded on a plea of trespass *quare clausum fregit*, entered on the records of the court) is a kind of *capias*, directed to the sheriff of that county, and commanding him to take the defendant, and have him before our lord the king at Westminster on a day prefixed, to answer to the plaintiff of a plea of trespass. For this accusation of trespass it is that gives the court of king's bench jurisdiction in other civil causes, since, when once the defendant is taken into custody of the marshal, or prison-keeper of this court, for the supposed trespass, he, being then a prisoner of this court, may here be prosecuted for any other species of injury. Yet, in order to found this jurisdiction, it is not necessary that the defendant be actually the marshal's prisoner; for, as soon as he appears, or puts in bail, to the process, he is deemed by so doing to be in such custody of the marshal as will give the court a jurisdiction to proceed. And, upon these accounts, in the bill or process, a complaint of trespass is always suggested, whatever else may be the real cause of action. This bill of Middlesex must be served on the defendant by the sheriff, if he finds him in that county: but if he returns, *non est inventus*, then there issues out a writ of *latitat*, to the sheriff of another county, as Berks; which is similar to the *testatum capias* in the common pleas, and recites the bill of Middlesex and the proceedings thereon, and that it is testified that the defendant *latitat et discurrit*, lurks and wanders about in Berks; and therefore commands the sheriff to take him, and have his body in court on the day of the return. But as in the common pleas the *testatum capias* may be sued out upon only a supposed, and not an actual preceding, *capias*; so in the king's bench a *latitat* is usually sued out upon only a supposed, and not an actual, bill of Middlesex. So that, in fact, a *latitat* may be called the first process in the court of king's bench, as the *testatum capias* is in the common pleas. Yet, as in the common pleas, if the defendant lives in the county wherein the action is laid, a common *capias* suffices; so in the king's bench likewise, if he lives in Middlesex, the process must still be by bill of Middlesex only.

In the exchequer the first process is by writ of *quo minus*, in order to give the court a jurisdiction over pleas between party and party. In which writ the plaintiff is alleged to be the king's farmer or debtor, and that the defendant hath done him the injury complained of, *quo minus sufficiens exiit*, by which he is the less able to pay the king his rent or debt. And upon this the defendant may be arrested as upon a *capias* from the common pleas.

Thus differently do the three courts set out at first, in the commencement of a suit, in order to intitle the two courts of king's bench and exchequer to hold plea in subjects causes, which by the original constitution of Westminster-hall they were not empowered to do. Afterwards, when the cause is once drawn into the respective courts, the method of pursuing it is pretty much the same in all of them.

If the sheriff had found the defendant upon any of the former writs, the *capias latitat*, &c. he was anciently obliged to take him into custody, in order to produce him in court upon the return, however small and minute the cause of action might be. For, not

having obeyed the original summons, he had shown a contempt of the court, and was no longer to be trusted at large. But when the summons fell into disuse, and the *capias* became in fact the first process, it was thought hard to imprison a man for a contempt which was only supposed: and therefore, in common cases, by the gradual indulgence of the courts (at length authorized by statute 12 Geo. I. c. 29. which was amended by statute 5 Geo. II. c. 27. and made perpetual by statute 21 Geo. II. c. 3.) the sheriff or his officer can now only personally serve the defendant with the copy of the writ or process, and with notice in writing to appear by his attorney in court to defend this action; which in effect reduces it to a mere summons. And if the defendant thinks proper to appear upon this notice, his appearance is recorded, and he puts in sureties for his future attendance and obedience; which sureties are called *common bail*, being the same two imaginary persons that were pledges for the plaintiff's prosecution, John Doe and Richard Roe. Or, if the defendant does not appear upon the return of the writ, or within four (or in some cases eight) days after, the plaintiff may enter an appearance for him, as if he had really appeared; and may file common bail in the defendant's name, and proceed thereupon as if the defendant had done it himself.

But if the plaintiff will make affidavit, or assert upon oath, that the cause of action amounts to ten pounds or upwards, then in order to arrest the defendant, and make him put in substantial sureties for his appearance, called *special bail*, it is required by statute 13 Car. II. stat. 2. c. 2. that the true cause of action should be expressed in the body of the writ or process: else no security can be taken in a greater sum than L. 40. This statute (without any such intention in the makers) had like to have ousted the king's bench of all its jurisdiction over civil injuries without force: for, as the bill of Middlesex was framed only for actions of trespass, a defendant could not be arrested and held to bail thereupon for breaches of civil contracts. But to remedy this inconvenience, the officers of the king's bench devised a method of adding what is called a clause of *ac etiam* to the usual complaint of trespass; the bill of Middlesex commanding the defendant to be brought in to answer the plaintiff of a plea of trespass, and also to a bill of debt: the complaint of trespass giving cognizance to the court, and that of debt authorizing the arrest. In imitation of which, lord chief justice North, a few years afterwards, in order to save the suitors of his court the trouble and expence of suing out special originals, directed, that in the common pleas, besides the usual complaint of breaking the plaintiff's close, a clause of *ac etiam* might be also added to the writ of *capias*, containing the true cause of action; as, "that the said Charles the defendant may answer to the plaintiff of a plea of trespass in breaking his close: and also, *ac etiam* may answer him, according to the custom of the court, in a certain plea of trespass upon the case, upon promises, to the value of L. 20, &c." The sum sworn to by the plaintiff is marked upon the back of the writ; and the sheriff, or his officer the bailiff, is then obliged actually to arrest or take into custody the body of the defendant, and, having so done, to return the writ with a *cepi corpus* indorsed thereon. See ARREST.

When the defendant is regularly arrested, he must either

Process.

Process.

either go to prison, for safe custody; or put in *special bail* to the sheriff. For, the intent of the arrest being only to compel an appearance in court at the return of the writ, that purpose is equally answered, whether the sheriff detains his person, or takes sufficient security for his appearance, called *bail* (from the French word *bail-ler*, "to deliver"), because the defendant is bailed, or delivered, to his sureties, upon their giving security for his appearance; and is supposed to continue in their friendly custody instead of going to gaol. See BAIL. The method of putting in bail to the sheriff is by entering into a bond or obligation, with one or more sureties, (not fictitious persons, as in the former case of common bail, but real, substantial, responsible bondsmen), to insure the defendant's appearance at the return of the writ; which obligation is called the *bail-bond*. The sheriff, if he pleases, may let the defendant go without any sureties; but that is at his own peril: for, after once taking him, the sheriff is bound to keep him safely, so as to be forthcoming in court; otherwise an action lies against him for an escape. But, on the other hand, he is obliged, by statute 23 Hen. VI. c. 10. to take (if it be tendered) a sufficient bail-bond; and, by statute 12 Geo. I. c. 29. the sheriff shall take bail for no other sum than such as is sworn to by the plaintiff, and indorsed on the back of the writ.

Upon the return of the writ, or within four days after, the defendant must *appear* according to the exigency of the writ. This *appearance* is effected by putting in and justifying bail to the action; which is commonly called *putting in bail above*. If this be not done, and the bail that were taken by the sheriff *below* are responsible persons, the plaintiff may take an assignment from the sheriff of the bail-bond (under the statute 4 & 5 Ann. c. 16.) and bring an action thereupon against the sheriff's bail. But if the bail so accepted by the sheriff be insolvent persons, the plaintiff may proceed against the sheriff himself, by calling upon him, first to return the writ (if not already done), and afterwards to bring in the body of the defendant. And if the sheriff does not then cause sufficient bail to be put in *above*, he will himself be responsible to the plaintiff.

The bail *above*, or bail to the action, must be put in either in open court, or before one of the judges thereof; or else, in the country, before a commissioner appointed for that purpose by virtue of the statute 4 W. & M. c. 4. which must be transmitted to the court. These bail, who must at least be two in number, must enter into a recognizance in court, or before the judge or commissioner, whereby they do jointly and severally undertake, that if the defendant be condemned in the action, he shall pay the costs and condemnation, or render himself a prisoner, or that they will pay it for him: which recognizance is transmitted to the court in a slip of parchment, intitled a *bail-piece*. And, if required, the bail must *justify* themselves in court, or before the commissioner in the country, by swearing themselves housekeepers, and each of them to be worth double the sum for which they are bail, after payment of all their debts. This answers in some measure to the *stipulatio* or *satisfactio* of the Roman laws, which is mutually given by each litigant party to the other: by the plaintiff that he will prosecute his suit, and pay the costs if he loses his cause; in like manner as our law

Process.

still requires nominal pledges of prosecution from the plaintiff: by the defendant, that he shall continue in court, and abide the sentence of the judge, much like our special bail; but with this difference, that the *fide-jussors* were there absolutely bound *judicatum solvere*, to see the costs and condemnation paid at all events: whereas our special bail may be discharged, by surrendering the defendant into custody within the time allowed by law; for which purpose they are at all times intitled to a warrant to apprehend him.

Special bail is required (as of course) only upon actions of debt, or actions on the case in trover, or for money due, where the plaintiff can swear that the cause of action amounts to ten pounds: but in actions where the damages are precarious, being to be assessed *ad libitum* by a jury, as in actions for words, ejectment, or trespass, it is very seldom possible for a plaintiff to swear to the amount of his cause of action; and therefore no special bail is taken thereon, unless by a judge's order, or the particular directions of the court, in some peculiar species of injuries, as in cases of mayhem or atrocious battery; or upon such special circumstances as make it absolutely necessary that the defendant should be kept within the reach of justice. Also in actions against heirs, executors, and administrators, for debts of the deceased, special bail is not demandable; for the action is not so properly against them in person, as against the effects of the deceased in their possession. But special bail is required even of them, in actions for a *devastavit*, or wasting the goods of the deceased; that wrong being of their own committing.

Thus much for *process*; which is only meant to bring the defendant into court, in order to contest the suit, and abide the determination of the law. When he appears either in person as a prisoner, or out upon bail, then follow the *pleadings* between the parties. See PLEADINGS.

PROCESS upon an Indictment. See PROSECUTION. The proper process on an indictment for any petty misdemeanour, or on a penal statute, is a writ of *venire facias*, which is in the nature of a summons to cause the party to appear. And if by the return to such *venire* it appears that the party hath lands in the county whereby he may be distrained, then a *distress infinite* shall be issued from time to time till he appears. But if the sheriff returns, that he hath no lands in his bailiwick, then (upon his non-appearance) a writ of *capias* shall issue, which commands the sheriff to take his body, and have him at the next assizes; and if he cannot be taken upon the first *capias*, a second and a third shall issue, called an *alias*, and a *pluries capias*. But, on indictments for treason or felony, a *capias* is the first process: and, for treason or homicide, only one shall be allowed to issue, or two in the case of other felonies, by statute 25 Edw. III. c. 14. though the usage is to issue only one in any felony; the provisions of this statute being in most cases found impracticable. And so, in the case of misdemeanours, it is now the usual practice for any judge of the court of king's bench, upon certificate of an indictment found, to award a writ of *capias* immediately, in order to bring in the defendant. But if he absconds, and it is thought proper to pursue him to an outlawry, then a greater exactness is necessary. For, in such case, after the several writs have issued in a regular number, according to the nature of the re-

spective

Process.

spective crimes, without any effect, the offender shall be put in the *exigent* in order to his outlawry: that is, he shall be exacted, proclaimed, or required, to surrender, at five county-courts; and if he be returned *quinto exactus*, and does not appear at the fifth exaction or requisition, then he is adjudged to be *outlawed*, or put out of the protection of the law; so that he is incapable of taking the benefit of it in any respect, either by bringing actions or otherwise.

The punishment, for outlawries upon indictments for misdemeanors, is the same as for outlawries upon civil actions; viz. forfeiture of goods and chattels. But an outlawry in treason or felony amounts to a conviction and attainder of the offence charged in the indictment, as much as if the offender had been found guilty by his country. His life is, however, still under the protection of the law, as hath elsewhere been observed; (see HOMICIDE): that though anciently an outlawed felon was said to have *caput lupinum*, and might be knocked on the head like a wolf, by any one that should meet him; because, having renounced all law, he was to be dealt with as in a state of nature, when every one that should find him might slay him: yet now, to avoid such inhumanity, it is holden that no man is intitled to kill him wantonly or wilfully; but in so doing is guilty of murder, unless it happens in the endeavour to apprehend him. For any person may arrest an outlaw on a criminal prosecution, either of his own head, or by writ or warrant of *capias ut loqatum*, in order to bring him to execution. But such outlawry may be frequently reversed by writ of error, the proceedings therein being (as it is fit they should be) exceedingly nice and circumstantial; and if any single minute point be omitted or misconducted, the whole outlawry is illegal, and may be reversed: upon which reversal the party accused is admitted to plead to, and defend himself against, the indictment.

Thus much for process to bring in the offender after indictment found; during which stage of the prosecution it is that writs of *certiorari facias* are usually had, though they may be had at any time before trial, to certify and remove the indictment, with all the proceedings thereon, from any inferior court of criminal jurisdiction into the court of king's bench; which is the sovereign ordinary court of justice in causes criminal. And this is frequently done for one of these four purposes; either, 1. To consider and determine the validity of appeals or indictments and the proceedings thereon; and to quash or confirm them as there is cause; or, 2. Where it is surmised that a partial or insufficient trial will probably be had in the court below, the indictment is removed, in order to have the prisoner or defendant tried at the bar of the court of king's bench, or before the justices of *nisi prius*: or, 3. It is so removed, in order to plead the king's pardon there: or, 4. To issue process of outlawry against the offender, in those counties or places where the process of the inferior judges will not reach him. Such writ of *certiorari*, when issued and delivered to the inferior court for removing any record or other proceeding, as well upon indictment as otherwise, supercedes the jurisdiction of such inferior court, and makes all subsequent proceedings therein entirely erroneous and illegal; unless the court of king's bench remands the record to the court below, to be there tried and determined. A

VOL. XV. Part II.

certiorari may be granted at the instance of either the prosecutor or the defendant: the former as a matter of right, the latter as a matter of discretion; and therefore it is seldom granted to remove indictments from the justices of gaol-delivery, or after issue joined, or confession of the fact in any of the courts below.

At this stage of prosecution also it is, that indictments found by the grand jury against a peer, null, in consequence of a writ of *certiorari*, be certified and transmitted into the court of parliament, or into that of the lord high steward of Great Britain; and that, in places of exclusive jurisdiction, as the two universities, indictments must be delivered (upon challenge and claim of cognizance) to the courts therein established by charter, and confirmed by act of parliament, to be there respectively tried and determined. See PLEA.

PROCESS, in chemistry, the whole course of an experiment or series of operations, tending to produce something new.

PROCESS, in anatomy, denotes any protuberance or eminence in a bone.

PROCESSION, a ceremony in the Romish church, consisting of a formal march of the clergy and people, putting up prayers, &c. and in this manner visiting some church, &c. They have also processions of the host or sacrament, &c. See HOST.

PROCHEIN AMY, in law, the person next akin to a child in non-age, and who, in that respect, is allowed to act for him, and be his guardian, &c. if he hold land in soccage.

To sue, an infant is not allowed to make an attorney; but the court will admit his next friend as plaintiff, or his guardian as defendant.

PROCKIA, in botany: A genus of the monogynia order, belonging to the polyandria class of plants; and in the natural method ranking with those of which the order is doubtful. The calyx is triphyllous, besides two leaflets at the base. There is no corolla; the berry is quinqueangular, and polyspermous.

PROCLAMATION, a public notice given of any thing of which the king thinks proper to advertise his subjects.

Proclamations are a branch of the king's prerogative*; and have then a binding force, when (as Sir Edward Coke observes) they are grounded upon and enforce the laws of the realm. For, though the making of laws is entirely the work of a distinct part, the legislative branch of the sovereign power, yet the manner, time, and circumstances of putting those laws in execution, must frequently be left to the discretion of the executive magistrate. And therefore his constitutions or edicts, concerning those points which we call *proclamations*, are binding upon the subject, where they do not either contradict the old laws, or tend to establish new ones; but only enforce the execution of such laws as are already in being, in such manner as the king shall judge necessary. Thus the established law is, that the king may prohibit any of his subjects from leaving the realm: a proclamation therefore forbidding this in general for three weeks, by laying an embargo upon all shipping in time of war, will be equally binding as an act of parliament, because founded upon a prior law. But a proclamation to lay an embargo in time of peace upon all vessels laden with wheat, (though in the time of a public scarcity), being contrary to law,

Process

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Proclama.

tion.

* See Prerogative.

Proclus and particularly to statute 22 Car. II. c. 13. the advisers of such a proclamation, and all persons acting under it, found it necessary to be indemnified by a special act of parliament, 7 Geo. III. c. 7. A proclamation for disarming Papists is also binding, being only in execution of what the legislature has first ordained: but a proclamation for allowing arms to Papists, or for disarming any Protestant subjects, will not bind; because the first would be to assume a dispensing power, the latter a legislative one; to the vesting of either of which in any single person the laws of England are absolutely strangers. Indeed, by the statute 31 Hen. VIII. c. 8. it was enacted, that the king's proclamations should have the force of acts of parliament: a statute, which was calculated to introduce the most despotic tyranny; and which must have proved fatal to the liberties of this kingdom, had it not been luckily repealed in the minority of his successor, about five years after. By a late act of parliament the king is empowered to raise regiments of Roman Catholics, to serve in the present war.

PROCLUS, surnamed **DIADOCHUS**, a Greek philosopher and mathematician, was born in Lycia, and lived about the year 500. He was the disciple of Syrianus, and had a great share in the friendship of the emperor Anastasius. It is said, that when Vitalian laid siege to Constantinople, Proclus burnt his ships with large brazen speculums. This philosopher was a Pagan, and wrote against the Christian religion. There are still extant his Commentaries on some of Plato's books, and other of his works written in Greek.

PROCONSUL, a Roman magistrate, sent to govern a province with consular authority.

The proconsuls were appointed out of the body of the senate; and usually as the year of any one's consulate expired, he was sent proconsul into some province.

The proconsuls decided cases of equity and justice, either privately in their pretorium or palace, where they received petitions, heard complaints, granted writs under their seal, and the like; or else publicly, in the common hall, with the usual formalities observed in the court of judicature at Rome. They had besides, by virtue of their edicts, the power of ordering all things relating to the tribunes, taxes, contributions, and provisions of corn and money, &c. Their office lasted only a year. See **CONSUL**.

PROCOPIUS, a famous Greek historian, born in Cæsaria, acquired great reputation by his works in the reign of Justinian, and was secretary to Belisarius during all the wars carried on by that general in Persia, Africa, and Italy. He at length became senator, obtained the title of *illustrious*, and was made pretor of Constantinople.

PROCREATION, the begetting and bringing forth young. See **GENERATION** and **SEMEN**.

PROCTOR, a person commissioned to manage another person's cause in any court of the civil or ecclesiastical law.

PROCTOR, in the English universities. See **UNIVERSITY**.

PROCURATION, an act or instrument by which a person is empowered to treat, transact, receive, &c. in another person's name.

PROCURATOR. See **PROCTOR**.

PRODICALITY, means extravagance, profusion, waste, or excessive liberality, and is the opposite ex-

treme to the vice of parsimony. By the Roman law, if a man by notorious prodigality was in danger of wasting his estate, he was looked upon as *non compos*, and committed to the care of curators, or tutors, by the prætor. And by the laws of Solon, such prodigals were branded with perpetual infamy.

PRODUCT, in arithmetic and geometry, the factum of two or more numbers, or lines, &c. into one another: thus $5 \times 4 = 20$ the product required.

PROEDRI, among the Athenians, were magistrates, who had the first seats at the public assemblies, and whose office it was to propose at each assembly the things to be deliberated upon and determined. Their office always ended with the meeting. Their number was nine, so long as the tribes were ten in number.

PROFANATION, the acting disrespectfully to sacred things.

PROFANE, a term used in opposition to *holy*; and in general is applied to all persons who have not the sacred character, and to things which do not belong to the service of religion.

PROFESSION means a calling, vocation, or known employment. In Knox's *Essays*, vol. 1st, page 234, we find an excellent paper on the choice of a profession, which that elegant writer concludes thus: "All the occupations of life (says he) are found to have their advantages and disadvantages admirably adapted to preserve the just equilibrium of happiness. This we may confidently assert, that, whatever are the inconveniences of any of them, they are all preferable to a life of inaction; to that wretched listlessness, which is constrained to pursue pleasure as a business, and by rendering it the object of severe and unvaried attention, destroys its very essence."

Among the Romanists profession denotes the entering into a religious order, whereby a person offers himself to God by a vow of inviolably observing obedience, chastity, and poverty.

PROFESSOR, in the universities, a person who teaches or reads public lectures in some art or science from a chair for the purpose.

PROFILE, in architecture, the draught of a building, fortification, &c. wherein are expressed the several heights, widths, and thickneses, such as they would appear were the building cut down perpendicularly from the roof to the foundation. Whence the profile is also called the *section*, sometimes *orthographical section*, and by Vitruvius also *sciagraphy*.

Profile, in this sense, amounts to the same with *elevation*; and stands opposed to a *plan* or *ichnography*.

PROFILE is also used for the contour or out-line of a figure, building, member of architecture, or the like; as a base, a cornice, &c. Hence *profiling* is sometimes used for designing, or describing the member with rule, compass, &c.

PROFILE, in sculpture and painting.—A head, a portrait, &c. are said to be in *profile*, when they are represented sidewise, or in a side-view; as, when in a portrait there is but one side of the face, one eye, one cheek, &c. shown, and nothing of the other.—On almost all medals, the faces are represented in *profile*.

PROFLUVIUM, in medicine, denotes a flux, or liquid evacuation of any thing.

PROGNOSTIC, among physicians, signifies a judgement concerning the event of a disease, as whether it shall end in life or death, be short or long, mild or malignant, &c.

PROGRAMMA,

Program-
ma.

PROGRAMMA, anciently signified a letter sealed with the king's seal.

Programma is also an university term for a billet or advertisement, posted up or given into the hand, by way of invitation to an oration, &c. containing the argument, or so much as is necessary for understanding thereof.

Thus $\left\{ \begin{array}{l} a, a+d, a+2d, a+3d, \&c. \text{ increasing} \\ a, a-d, a-2d, a-3d, \&c. \text{ decreasing} \end{array} \right\}$ by the difference d .
In numbers $\left\{ \begin{array}{l} 2, 4, 6, 8, 10, \&c. \text{ increasing} \\ 10, 8, 6, 4, 2, \&c. \text{ decreasing} \end{array} \right\}$ by the difference 2.

Geometric Progression, or Continued Geometric Proportion, is when the terms do increase or decrease by equal ratios: thus,

$\left\{ \begin{array}{l} a, ar, arr, arrr, \&c. \text{ increasing} \\ a, \frac{a}{r}, \frac{a}{rr}, \frac{a}{rrr}, \&c. \text{ decreasing} \end{array} \right\}$ from a continual $\left\{ \begin{array}{l} \text{multiplication} \\ \text{division} \end{array} \right\}$ by r .
 $\left\{ \begin{array}{l} 2, 4, 8, 16, 32, 64, \text{ increasing} \\ 64, 32, 16, 8, 4, 2, \text{ decreasing} \end{array} \right\}$ from a continual $\left\{ \begin{array}{l} \text{multiplication} \\ \text{division} \end{array} \right\}$ by 2.

See the articles FLUXIONS, GEOMETRY, and SERIES.

P R O J E C T I L E S.

1
Object of
the science.2
Effect of
gravity on
projected
bodies.

THIS is the name for that part of mechanical philosophy which treats of the motion of bodies any how projected from the surface of this earth, and influenced by the action of terrestrial gravity.

It is demonstrated in the physical part of astronomy that a body so projected must describe a conic section, having the centre of the earth in one focus; and that it will describe round that focus areas proportional to the times. And it follows from the principles of that science, that if the velocity of projection exceeds 36700 feet in a second, the body (if not resisted by the air) would describe a hyperbola; if it be just 36700, it would describe a parabola; and if it be less than this, it would describe an ellipsis. If projected directly upwards, in the first case, it would never return, but proceed for ever; its velocity continually diminishing, but never becoming less than an assignable portion of the excess of the initial velocity above 36700 feet in a second; in the second case, it would never return, its velocity would diminish without end, but never be extinguished. In the third case, it would proceed till its velocity was reduced to an assignable portion of the difference between 36700 and its initial velocity; and would then return, regaining its velocity by the same degrees, and in the same places, as it lost it. These are necessary consequences of a gravity directed to the centre of the earth, and inversely proportional to the square of the distance. But in the greatest projections that we are able to make, the gravitations are so nearly equal, and in directions so nearly parallel, that it would be ridiculous affectation to pay any regard to the deviations from equality and parallelism. A bullet rising a mile above the surface of the earth loses only $\frac{1}{1000}$ of its weight, and a horizontal range of 4 miles makes only 4' of deviation from parallelism.

Let us therefore assume gravitation as equal and parallel. The errors arising from this assumption are quite insensible in all the uses which can be made of this theory.

The theory itself will ever be regarded with some veneration and affection by the learned. It was the first fruits of mathematical philosophy. Galileo was the first who applied mathematical knowledge to the

PROGRESSION, in general, denotes a regular advancing, or going forward, in the same course and manner.

PROGRESSION, in mathematics, is either arithmetical or geometrical. Continued arithmetic proportion is, where the terms do increase and decrease by equal differences, and is called *arithmetical progression*:

Progres-
sion.

motions of free bodies, and this was the subject on which he exercised his fine genius.

Gravity must be considered by us as a constant or uniform accelerating or retarding force, according as it produces the descent, or retards the ascent, of a body. A constant or invariable accelerating force is one which produces an uniform acceleration; that is, which in equal times produces equal increments of velocity, and therefore produces increments of velocity proportional to the times in which they are produced. Forces are of themselves imperceptible, and are seen only in their effects; and they have no measure but the effect, or what *measures* the effect; and every thing which we can discover with regard to those measures, we must affirm with regard to the things of which we assume them as the measures. Therefore,

The motion of a falling body, or of a body projected directly downwards, is uniformly accelerated; and that of a body projected directly upwards is uniformly retarded: that is, the acquired velocities are as the times in which they are acquired by falling, and the extinguished velocities are as the times in which they are extinguished.

Cor. 1. If bodies simply fall, not being projected downwards by any external force, the times of the falls are proportional to the final velocities; and the times of ascents, which terminate by the action of gravity alone, are proportional to the initial velocities.

2. The spaces described by a heavy body falling from rest are as the squares of the acquired velocities; and the differences of these spaces are as the differences of the squares of the acquired velocities: and, on the other hand, the heights to which bodies projected upwards will rise, before their motions be extinguished, are as the squares of the initial velocities.

3. The spaces described by falling bodies are proportional to the squares of the times from the beginning of the fall; and the spaces described by bodies projected directly upwards are as the squares of the times of the ascents.

4. The space described by a body falling from rest is one half of the space which the body would have uniformly described in the same time, with the velocity ac-

quired by the fall.—And the height to which a body will rise, in opposition to the action of gravity, is one half of the space which it would uniformly describe in the same time with the initial velocity.

In like manner the difference of the spaces which a falling or rising body describes in any equal successive parts of its fall or rise, is one half of the space which it would uniformly describe in the same time with the difference of the initial and final velocities.

This proposition will be more conveniently expressed for our purpose thus :

A body moving uniformly during the time of any fall with the velocity acquired thereby, will in that time describe a space double of that fall ; and a body projected directly upwards will rise to a height which is one half of the space which it would, uniformly continued, describe in the time of its ascent with the initial velocity of projection.

These theorems have been already demonstrated in a popular way, in the article MECHANICS, sect. vi. § 14, 15, 16, &c. and in GUNNERY. But we would recommend to our readers the 39th prop. of the first book of Newton's *Principia*, as giving the most general investigation of this subject ; equally easy with these more loose methods of demonstration, and infinitely superior to them, by being equally applicable to every variation of the accelerating force. See an excellent application of this proposition by Mr Robins, for defining the motion of a ball discharged from a cannon, in the article GUNNERY, n° 15. See another in OPTICS, n° 127. for defining the motion of light in refraction, &c.

6
The force of gravity in falling bodies can be ascertained.

5. It is a matter of observation and experience, that a heavy body falls 16 feet and an inch English measure in a second of time ; and therefore acquires the velocity of 32 feet 2 inches *per* second. This cannot be ascertained directly, with the precision that is necessary. A second is too small a portion of time to be exactly measured and compared with the space described ; but it is done with the greatest accuracy by comparing the motion of a falling body with that of a pendulum. The time of a vibration is to the time of falling through half the length of the pendulum, as the circumference of a circle is to its diameter. The length of a pendulum can be ascertained with great precision ; and it can be lengthened or shortened till it makes just 86,400 vibrations in a day : and this is the way in which the space fallen through in a second has been accurately ascertained.

As all other forces are ascertained by the accelerations which they produce, they are conveniently measured by comparing their accelerations with the acceleration of gravity. This therefore has been assumed by all the later and best writers on mechanical philosophy, as the unit by which every other force is measured. It gives us a perfectly distinct notion of the force which retains the moon in its orbit, when we say it is the 3600th part of the weight of the moon at the surface of the earth. We mean by this, that if a bullet were here weighed by a spring steel-yard, and pulled it out to the mark 3600 ; if it were then taken to the distance of the moon, it would pull it out only to the mark 1. And we make this assertion on the authority of our having observed that a body at the distance of the moon falls from that distance $\frac{1}{3600}$ part of 16 feet in a second. We do not, therefore, compare the *forces*, which

are imperceptible things ; we compare the accelerations, which are their indications, effects, and measures.

This has made philosophers so anxious to determine with precision the fall of heavy bodies, in order to have an exact value of the accelerating power of terrestrial gravity. Now we must here observe, that this measure may be taken in two ways : we may take the space through which the heavy body falls in a second ; or we may take the velocity which it acquires in consequence of gravity having acted on it during a second. The last is the proper measure ; for the last is the immediate effect on the body. The action of gravity has changed the state of the body—in what way ? by giving it a determination to motion downward : this both points out the kind and the degree or intensity of the force of gravity. The space described in a second by falling, is not an invariable measure ; for, in the successive seconds, the body falls through 16, 48, 80, 112, &c. feet, but the changes of the bodies state in each second is the same. At the beginning it had no determination to move with any appreciable velocity ; at the end of the first second it had a determination by which it would have gone on for ever (had no subsequent force acted on it) at the rate of 32 feet *per* second. At the end of the second second, it had a determination by which it would have moved for ever, at the rate of 64 feet *per* second. At the end of the third second, it had a determination by which it would have moved for ever, at the rate of 96 feet *per* second, &c. &c. The difference of these determinations is a determination to the rate of 32 feet *per* second. This is therefore constant, and the indication and proper measure of the constant or invariable force of gravity. The space fallen through in the first second is of use only as it is one half of the measure of this determination ; and as halves have the proportion of their wholes, different accelerating forces may be safely affirmed to be in the proportion of the spaces through which they uniformly impel bodies in the same time. But we should always recollect, that this is but one half of the true measure of the accelerating force. Mathematicians of the first rank have committed great mistakes by not attending to this ; and it is necessary to notice it just now, because cases will occur in the prosecution of this subject, where we shall be very apt to confound our reasonings by a confusion in the use of those measures. Those mathematicians who are accustomed to the geometrical consideration of curvilinear motions, are generally disposed to take the *actual deflection* from the tangent as the measure of the deflecting force ; while those who treat the same subject algebraically, by the assistance of fluxions, take the *change of velocity*, which is measured by *twice* the deflection. The reason is this : when a body passes through the point B of a curve ABC, fig. 1. if the deflecting force were to cease at that instant, the body would describe the tangent BD in the same time in which it describes the arch BC of the curve, and DC is the deflection, and is therefore taken for the measure of the deflecting force. But the algebraist is accustomed to consider the curve by means of an equation between the abscissæ Ha, Hb, Hc, and their respective ordinates Aa, Bb, Cc ; and he measures the deflections by the changes made on the increments of the ordinates. Thus the increment of the ordinate Aa, while the body describes the arch AB of the curve, is BG. If the deflecting force were to cease

7
Two modes of determining the fall of heavy bodies.

8
Mistakes of mathematicians on this subject.

Plate
CCCCXV.

9
Particular-
ly of Leib-
nitz.

cease when the body is at B, the next increment would have been equal to BG, that is, it would have been EF; but, in consequence of the deflection, it is only CF: therefore he takes EC for the measure of the deflection, and of the deflecting force. Now EC is ultimately twice DC; and thus the measure of the algebraist (derived solely from the nature of the differential method, and without any regard to physical considerations) happens to coincide with the true physical measure. There is therefore great danger of mixing these measures. Of this we cannot give a more remarkable instance than Leibnitz's attempt to demonstrate the elliptical motion of the planets in the *Leipsc Acts*, 1689. He first considers the subject mechanically, and takes the deflection or DC for the measure of the deflecting force. He then introduces his differential calculus, where he takes the difference of the increments for the measure; and thus brings himself into a confusion, which luckily compensates for the false reasoning in the preceding part of his paper, and gives his result the appearance of a demonstration of Newton's great discovery, while, in fact, it is a confused jumble of assumptions, self-contradictory, and inconsistent with the very laws of mechanics which are used by him in the investigation. Seventeen years after this, in 1706, having been criticised for his bad reasoning, or rather accused of an envious and unsuccessful attempt to appropriate Newton's inventions to himself, he gives a correction of his paralogism, which he calls a correction of language. But he either had not observed where the paralogism lay, or would not let himself down by acknowledging a mistake in what he wished the world to think his own calculus (fluxions); he applied the correction where no fault had been committed, for he had measured both the centrifugal force and the sollicitation of gravity in the same way, but had applied the fluxionary expression to the last and not to the first, and, by so doing, he completely destroyed all coincidence between his result and the planetary motions. We mention this instance, not only as a caution to our mathematical readers, but also as a very curious literary anecdote. This dissertation of Leibnitz is one of the most obscure of his obscure writings, but deserves the attention of an intelligent and curious reader, and cannot fail of making an indelible impression on his mind, with relation to the modesty, candour, and probity of the author. It is preceded by a dissertation on the subject which we are now entering upon, the motion of projectiles in a resisting medium. Newton's *Principia* had been published a few years before, and had been reviewed, in a manner shamefully slight, in the *Leipsc Acts*. Both these subjects make the capital articles of that immortal work. Mr Leibnitz published these dissertations, without (says he) having seen Newton's book, in order to show the world that he had, some years before, discovered the same theorems. Mr Nicholas Fatio carried a copy of the *Principia* from the author to Hanover in 1686, where he expected to find Mr Leibnitz; he was then absent, but Fatio saw him often before his return to France in 1687, and does not say that the book was not given him. Read along with these dissertations Dr Keill's letter to John Bernoulli and others, published in the *Journal Littéraire de la Haye* 1714, and to John Bernoulli in 1719.

Newton has been accused of a similar oversight by John Bernoulli, (who indeed calls it a mistake in prin-

ciple) in his Proposition X. Book 2. on the very subject we are now considering. But Dr Keill has shown it to be only an oversight, in drawing the tangent on the wrong side of the ordinate. For in this very proposition Newton exhibits, in the strictest and most beautiful manner, the difference between the geometrical and algebraical manner of considering the subject; and expressly warns the reader, that his algebraical symbol expresses the deflection only, and not the variation of the increment of the ordinate. It is therefore in the last degree improbable that he would make this mistake. He most expressly does not; and as to the real mistake, which he corrected in the second edition, the writer of this article has in his possession a manuscript copy of notes and illustrations on the whole *Principia*, written in 1693 by Dr David Gregory, Savilian professor of astronomy at Oxford, at the desire of Mr Newton, as preparatory for a new edition, where he has rectified this and several other mistakes in that work, and says that Mr Newton had seen and approved of the amendments. We mention these particulars, because Mr Bernoulli published an elegant dissertation on this subject in the *Leipsc Acts* in 1713; in which he charges Newton (though with many protestations of admiration and respect) with this mistake in principle; and says, that he communicated his correction to Mr Newton by his nephew Nicholas Bernoulli, that it might be corrected in the new edition, which he heard was in the press. And he afterwards adds, that it appears by some sheets being cancelled, and new ones substituted in this part of the work, that the mistake would have continued, had he not corrected it. We would desire our readers to consult this dissertation, which is extremely elegant, and will be of service to us in this article; and let them compare the civil things which is here said of the *vir incomparabilis*, the *omni laude major*, the *summus Newtonus*, with what the same author, in the same year, in the *Leipsc Acts*, but under a borrowed name, says of him. Our readers will have no hesitation in ascribing this letter to this author. For, after praising John Bernoulli as *summus geometra, natus ad summorum geometrarum paralogismos corrigendos, summi candoris ut et modestie*, he betrays himself by an unguarded warmth, when defending J. B.'s demonstration of the inverse problem of centripetal forces, by calling it *MEAM demonstrationem*.

Let our readers now consider the scope and intention of this dissertation on projectiles, and judge whether the author's aim was to instruct the world, or to acquire fame, by correcting Newton. The dissertation does not contain one theorem, one corollary, nor one step of argument, which is not to be found in Newton's first edition; nor has he gone farther than Newton's single proposition the Xth. To us it appears an exact companion to his proposition on centripetal forces, which he boasts of having first demonstrated, although it is in every step a transcript of the 42d of the 1st Book of Newton's *Principia*, the geometrical language of Newton being changed into algebraic, as he has in the present case changed Newton's algebraic analysis into a very elegant geometrical one.

We hope to be forgiven for this long digression. It is a very curious piece of literary history, and shows the combination which envy and want of honourable principle had formed against the reputation of our illustrious

10
Newton ac-
cused of a
similar mis-
take by J.
Bernoulli,

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But falsey.

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Insincerity
of Bernoulli
with respect
to Newton.

illustrious countryman; and we think it our duty to embrace any opportunity of doing it justice.—To return to our subject :

13 Accurate measure of the accelerative power of gravity, is the fall $16\frac{1}{2}$ feet, if we measure it by the space, or the velocity of $32\frac{1}{2}$ feet per second, if we take the velocity. It will greatly facilitate calculation, and will be sufficiently exact for all our purposes, if we take 16 and 32, supposing that a body falls 16 feet in a second, and acquires the velocity of 32 feet per second. Then, because the heights are as the squares of the times, and as the squares of the acquired velocities, a body will fall one foot in one fourth of a second, and will acquire the velocity of eight feet per second. Now let h express the height in feet, and call it the PRODUCING HEIGHT; v the velocity in feet per second, and call it the PRODUCED VELOCITY, the velocity DUE; and t the time in seconds.—We shall have the following formulæ, which are of easy recollection, and will serve, without tables, to answer all questions relative to projectiles.

$$\text{I. } v = 8\sqrt{h}, = 8 \times 4t, = 32t$$

$$\text{II. } t = \frac{\sqrt{h}}{4}, = \frac{v}{32}$$

$$\text{III. } \sqrt{h} = \frac{v}{8}, = 4t$$

$$\text{IV. } h = \frac{v^2}{64}, = 16t^2$$

15 Examples of their use, let it be required, To give some examples of their use, let it be required, 1. To find the time of falling through 256 feet.

Here $h = 256$, $\sqrt{256} = 16$, and $\frac{16}{4} = 4$. Answer 4".

2. To find the velocity acquired by falling four seconds. $t = 4$. $32 \times 4 = 128$ feet per second.

3. To find the velocity acquired by falling 625 feet. $h = 625$. $\sqrt{h} = 25$. $8\sqrt{h} = 200$ feet per second.

16 In bodies projected upwards, 4. To find the height to which a body will rise when projected with the velocity of 56 feet per second, or the height through which a body must fall to acquire this velocity.

$$v = 56. \frac{56}{8} = 7, = \sqrt{h}. 7^2 = h, = 49 \text{ feet.}$$

$$\text{or } 56^2 = 3136. \frac{3136}{64} = 49 \text{ feet.}$$

17 And directly downwards. 5. Suppose a body projected directly downwards with the velocity of 10 feet per second; what will be its velocity after four seconds? In four seconds it will have acquired, by the action of gravity, the velocity of 4×32 , or 128 feet, and therefore its whole velocity will be 138 feet per second.

6. To find how far it will have moved, compound its motion of projection, which will be 40 feet in four seconds, with the motion which gravity alone would have given it in that time, which is 256 feet; and the whole motion will be 296 feet.

7. Suppose the body projected as already mentioned, and that it is required to determine the time it will take to go 296 feet downwards, and the velocity it will have acquired.

Find the height x , through which it must fall to acquire the velocity of projection, 10 feet, and the time

y of falling from this height. Then find the time z of falling through the height $296 + x$, and the velocity v acquired by this fall. The time of describing the 296 feet will be $z - y$, and v is the velocity required.

From such examples, it is easy to see the way of answering every question of the kind.

18 Writers on the higher parts of mechanics always compute the actions of other accelerating and retarding forces by comparing them with the acceleration of gravity, and in order to render their expressions more general, use a symbol, such as g for gravity, leaving the reader to convert it into numbers. Agreeably to this view, the general formulæ will stand thus :

$$\text{I. } v = \sqrt{2gh}, \text{ i. e. } \sqrt{2g} \sqrt{h}, = \frac{v}{g} t,$$

$$\text{II. } t = \frac{v}{g}, = \frac{\sqrt{4b}}{\sqrt{2g}}, = \sqrt{\frac{4b}{2g}}, = \sqrt{\frac{2b}{g}}$$

$$\text{III. } h = \frac{v^2}{2g}, = \frac{g t^2}{2}$$

In all these equations, gravity, or its accelerating power, is estimated, as it ought to be, by the change of velocity which it generates in a particle of matter in an unit of time. But many mathematicians, in their investigations of curvilinear and other varied motions, measure it by the deflection which it produces in this time from the tangent of the curve, or by the increment by which the space described in an unit of time exceeds the space described in the preceding unit. This is but one half of the increment which gravity would have produced, had the body moved through the whole moment with the acquired addition of velocity. In this sense of the symbol g , the equations stand thus :

$$\text{I. } v = 2\sqrt{gh}, = 2gt$$

$$\text{II. } t = \sqrt{\frac{h}{g}}, = \frac{v}{2g}$$

$$\text{IV. } h = \frac{v^2}{4g}, = g t^2, \text{ and } \sqrt{h} = \frac{v}{2\sqrt{g}}$$

It is also very usual to consider the accelerating force of gravity as the unit of comparison. This renders the expressions much more simple. In this way, v expresses not the velocity, but the height necessary for acquiring it, and the velocity itself is expressed by \sqrt{v} . To reduce such an expression of a velocity to numbers, we must multiply it by $\sqrt{2g}$, or by $2\sqrt{g}$, according as we make g to be the generated velocity, or the space fallen through in the unit of time.

This will suffice for the perpendicular ascents or descents of heavy bodies, and we proceed to consider their motions when projected obliquely. The circumstance which renders this an interesting subject, is, that the flight of cannon shot and shells are instances of such motion, and the art of gunnery must in a great measure depend on this doctrine.

Let a body B (fig. 2.), be projected in any direction BC, not perpendicular to the horizon, and with any velocity. Let AB be the height producing this velocity; that is, let the velocity be that which a heavy body would acquire by falling freely through AB. It is required to determine the path of the body, and all the circumstances of its motion in this path?

1. It is evident, that by the continual action of gravity,

vity, the body will be continually deflected from the line BC, and will describe a curve line BVG, concave towards the earth.

20
Describes
a parabola.

2. This curve line is a parabola, of which the vertical line ABE is a diameter, B the vertex of this diameter, and BC a tangent in B.

Through any two points V, G of the curve draw VC, GH parallel to AB, meeting BC in C and H, and draw VE, GK parallel to BC, meeting AB in E, K. It follows, from the composition of motions, that the body would arrive at the points V, G of the curve in the same time that it would have uniformly described BC, BH, with the velocity of projection; or that it would have fallen through BE, BK, with a motion uniformly accelerated by gravity; therefore the times of describing BC, BH, uniformly, are the same with the times of falling through BE, BK. But, because the motion along BH is uniform, BC is to BH as the time of describing BC to the time of describing BH, which we may express thus, $BC : BH = T : T$, $BC : T, BH = T, BE : T, BK$. But, because the motion along BK is uniformly accelerated, we have $BE : BK = T^2 : BE : T^2, BK = BC^2 : BH^2 = EV^2 : KG^2$; therefore the curve BVG is such, that the abscissæ BE, BK are as the squares of the corresponding ordinates EV, KG; that is, the curve BVG is a parabola, and BC, parallel to the ordinates, is a tangent in the point B.

3. If through the point A there be drawn the horizontal line AD *d*, it is the directrix of the parabola.

Let BE be taken equal to AB. The time of falling through BE is equal to the time of falling through AB; but BC is described with the velocity acquired by falling through AB: and therefore by n° 4. of perpendicular descents, BC is double of AB, and EV is double of BE; therefore $EV^2 = 4BE^2 = 4BE \times AB = BE \times 4AB$, and 4AB is the parameter or *latus rectum* of the parabola BVG, and AB being one-fourth of the parameter, AD is the directrix.

4. The times of describing the different arches BV, VG of the parabola are as the portions BC, BH of the tangent, or as the portions AD, A *d* of the directrix, intercepted by the same vertical lines AB, CV, HG; for the times of describing BV, BVG are the same with those of describing the corresponding parts BC, BH of the tangent, and are proportional to these parts, because the motion along BH is uniform; and BC, BH are proportional to AD, A *d*.

Therefore the motion estimated horizontally is uniform.

5. The velocity in any point G of the curve is the same with that which a heavy body would acquire by falling from the directrix along *dG*. Draw the tangent GT, cutting the vertical AB in T; take the points *a*, *f*, equidistant from A and *d*, and extremely near them, and draw the verticals *ab*, *fg*; let the points *a*, *f*, continually approach A and *d*, and ultimately coincide with them. It is evident that B*b* will ultimately be to *gG*, in the ratio of the velocity at B to the velocity at G; for the portions of the tangent ultimately coincide with the portions of the curve, and are described in equal times; but B*b* is to *gG* as BH to TG: therefore the velocity at B is to that at G as BH to TG. But, by the properties of the parabola, BH² is to

TG² as AB to *dG*; and AB is to *dG* as the square of the velocity acquired by falling through AB to the square of the velocity acquired by falling through *dG*; and the velocity in BH, or in the point B of the parabola, is the velocity acquired by falling along AB; therefore the velocity in TG, or in the point G of the parabola, is the velocity acquired by falling along *dG*.

These few simple propositions contain all the theory of the motion of projectiles in vacuo, or independent on the resistance of the air; and being a very easy and neat piece of mathematical philosophy, and connected with very interesting practice, and a very respectable profession, they have been much commented on, and have furnished matter for many splendid volumes. But the air's resistance occasions such a prodigious diminution of motion in the great velocities of military projectiles, that this parabolic theory, as it is called, is hardly of any use. A musket-ball, discharged with the ordinary allotment of powder, issues from the piece with the velocity of 1670 feet per second: this velocity would be acquired by falling from the height of eight miles. If the piece be elevated to an angle of 45°, the parabola should be of such extent that it would reach 16 miles on the horizontal plain; whereas it does not reach much above half a mile. Similar deficiencies are observed in the ranges of cannon shot.

We do not propose, therefore, to dwell much on this theory; and shall only give such a synoptical view of it as shall make our readers understand the more general circumstances of the theory, and be masters of the language of the art.

Let OB (fig. 3.) be a vertical line. About the centres A and B, with the distance AB, describe the semicircles ODB, AHK, and with the axis AB, and semiaxis GE, equal to AB, describe the semi-ellipse AEB: with the focus B, vertex A, diameter AB, and tangent AD, parallel to the horizon, describe the parabola APS.

Let a body be projected from B, in any direction BC, with the velocity acquired by falling through AB. By what has already been demonstrated, it will describe a parabola BVPM. Then,

1. ADL parallel to the horizon is the directrix of every parabola which can be described by a body projected from B with this velocity. This is evident.

2. The semicircle AHK is the locus of all the foci of these parabolas: For the distance BH of a point B of any parabola from the directrix AD is equal to its distance BF from the focus F of that parabola; therefore the foci of all the parabolas which pass through B, and have AD for their directrix, must be in the circumference of the circle which has AB for its radius, and B for its centre.

3. If the line of direction BC cut the upper semicircle in C, and the vertical line CF be drawn, cutting the lower semicircle in F, F is the focus of the parabola BVPM, described by the body which is projected in the direction BC, with the velocity acquired by falling through BA: for drawing AC, BF, it is evident that ACFB is a rhombus, and that the angle ABF is bisected by BC, and therefore the focus lies in the line BF; but it also lies in the circumference AFK, and therefore in F.

If C is in the upper quadrant of ODB, F is in the upper

21
The parabolic theory ingenious, but of little use in practice.

22
A short view of it.

Plate
cccccix.

upper quadrant of AFK; and if C be in the lower quadrant of ODB (as when BC is the line of direction) then the focus of the corresponding parabola B v M is in the lower quadrant of AHK, as at f.

4. The ellipsis AEB is the locus of the vertex of all the parabolas, and the vertex V of any one of them BVPM is in the intersection of this ellipsis with the vertical CF: for let this vertical cut the horizontal lines AD, GE, BN, in θ , λ , N. Then it is plain that $N\lambda$ is half of $N\theta$, and λV is half of $C\theta$; therefore NV is half of NC, and V is the vertex of the axis.

If the focus is in the upper or lower quadrant of the circle AHK, the vertex is in the upper or the lower quadrant of the ellipse AEG.

5. If BFP be drawn through the focus of any one of the parabolas, such as BVM, cutting the parabola APS in P, the parabola BVM touches the parabola APS in P: for drawing P δ \times parallel to AB, cutting the directrix O \times of the parabola APS in \times , and the directrix AL of the parabola BVM in δ , then PB = P δ ; but BF = BA, = AO, = $\times\delta$: therefore P δ = PF, and the point P is in the parabola BVM. Also the tangents to both parabolas in P coincide, for they bisect the angle \times PB; therefore the two parabolas having a common tangent, touch each other in P.

Cor. All the parabolas which can be described by a body projected from B, with the velocity acquired by falling through AB, will touch the concavity of the parabola APS, and lie wholly within it.

6. P is the most distant point of the line BP which can be hit by a body projected from B with the velocity acquired by falling through AB. For if the direction is more elevated than BC, the focus of the parabola described by the body will lie between F and A, and the parabola will touch APS in some point between P and A; and being wholly within the parabola APS, it must cut the line BP in some point within P. The same thing may be shown when the direction is less elevated than BC.

7. The parabola APS is the locus of the greatest ranges on any planes BP, BS, &c. and no point lying without this parabola can be struck.

8. The greatest range on any plane BP is produced when the line of direction BC bisects the angle OBP formed by that plane with the vertical: for the parabola described by the body in this case touches APS in P, and its focus is in the line BP, and therefore the tangent BC bisects the angle OBP.

Cor. The greatest range on a horizontal plane is made with an elevation of 45° .

9. A point M in any plane BS, lying between B and S, may be struck with two directions, BC and Bc; and these directions are equidistant from the direction Bt, which gives the greatest range on that plane: for if about the centre M, with the distance ML from the directrix AL, we describe a circle L F f, it will cut the circle AHK in two points F and f, which are evidently the foci of two parabolas BVM, B v M, having the directrix AL and diameter ABK. The intersection of the circle ODB, with the verticals FC, f c, determine the directions BC, Bc of the tangents. Draw At parallel to BS, and join t B, C c, F f; then OB t = $\frac{1}{2}$ OBS, and B t is the direction which gives the greatest range on the plane BS: but because F f is a chord of the circles described round the centres B and

M, F f is perpendicular to BM, and C c to A t, and the arches C t, c t are equal; and therefore the angles CB t, c B t are equal.

Thus we have given a general view of the subject, which shows the connection and dependence of every circumstance which can influence the result; for it is evident that to every velocity of projection there belongs a set of parabolas, with their directions and ranges; and every change of velocity has a line AB corresponding to it, to which all the others are proportional. As the height necessary for acquiring any velocity increases or diminishes in the duplicate proportion of that velocity, it is evident that all the ranges with given elevations will vary in the same proportion, a double velocity giving a quadruple range, a triple velocity giving a nonuple range, &c. And, on the other hand, when the ranges are determined beforehand (which is the usual case), the velocities are in the subduplicate proportion of the ranges. A quadruple range will require a double velocity, &c.

On the principles now established is founded the ordinary theory of gunnery, furnishing rules which are to direct the art of throwing shot and shells, so as to hit the mark with a determined velocity. 23
Experience principally directs the practical gunner.

But we must observe, that this theory is of little service for directing us in the practice of cannonading. Here it is necessary to come as near as we can to the object aimed at, and the hurry of service allows no time for geometrical methods of pointing the piece after each discharge. The gunner either points the cannon directly to the object, when within 200 or 300 yards of it, in which case he is said to shoot point blank (*pointer au blanc*, i. e. at the white mark in the middle of the gunners target); or, if at a greater distance, he estimates to the best of his judgment the deflection corresponding to his distance, and points the cannon accordingly. In this he is aided by the greater thickness at the breech of a piece of ordnance. Or, lastly, when the intention is not to batter, but to rake along a line occupied by the enemy, the cannon is elevated at a considerable angle, and the shot discharged with a small force, so that it drops into the enemy's post, and bounds along the line. In all these services the gunner is directed entirely by trial, and we cannot say that this parabolic theory can do him any service.

The principal use of it is to direct the bombardier in throwing shells. With these it is proposed to break down or set fire to buildings, to break through the vaulted roofs of magazines, or to intimidate and kill troops by bursting among them. These objects are always under cover of the enemy's works, and cannot be touched by a direct shot. The bombs and carcasses are therefore thrown upwards, so as to get over the defences and produce their effect.

These shells are of very great weight, frequently exceeding 200 lbs. The mortars from which they are discharged must therefore be very strong, that they may resist the explosion of gunpowder which is necessary for throwing such a mass of matter to a distance; they are consequently unwieldy, and it is found most convenient to make them almost a solid and immoveable lump. Very little change can be made in their elevation, and therefore their ranges are regulated by the velocities given to the shell. These again are produced by the quantities

of powder in the charge; and experience (confirming the best theoretical notions that we can form of the subject) has taught us, that the ranges are nearly proportional to the quantities of powder employed, only not increasing quite so fast. This method is much easier than by differences of elevation; for we can select the elevation which gives the greatest range on the given plane, and then we are certain that we are employing the smallest quantity of powder with which the service can be performed: and we have another advantage, that the deviations which unavoidable causes produce in the real directions of the bomb will then produce the smallest possible deviation from the intended range. This is the case in most mathematical maxima.

24
The moving force in theory different from that in practice.

Plate
CCCCXVII.

In military projectiles the velocity is produced by the explosion of a quantity of gunpowder; but in our theory it is conceived as produced by a fall from a certain height, by the proportions of which we can accurately determine its quantity. Thus a velocity of 1600 feet per second is produced by a fall from the height of 40,000 feet or 1333 yards.

The height CA (fig. 4.) for producing the velocity of projection is called, in the language of gunnery, the IMPETUS. We shall express it by the symbol h .

The distance AB to which the shell goes on any plane AB is called the AMPLITUDE or the RANGE r .

The angle DBA, made by the vertical line and the plane AB, may be called the angle of POSITION of that plane, p .

The angle DAB, made by the axis or direction of the piece, and the direction of the object, may be called the angle of ELEVATION of the piece above the plane AB, e .

The angle ZAD, made by the vertical line, and the direction of the piece, may be called the ZENITH distance, z .

The relations between all the circumstances of velo-

city, distance, position, elevation, and time, may be included in the following propositions.

I. Let a shell be projected from A, with the velocity acquired by falling through CA, with the intention of hitting the mark B situated in the given line AB.

25
Relations between the velocity, distance, &c.

Make $ZA = 4AC$, and draw BD perpendicular to the horizon. Describe on ZA an arch of a circle ZDA, containing an angle equal to DBA, and draw AD to the intersection of this circle with DB; then will a body projected from A, in the direction AD, with the velocity acquired by falling through CA, hit the mark B.

For, produce CA downwards, and draw BF parallel to AD, and draw ZD. It is evident from the construction that AB touches the circle in B, and that the angles ADZ, DBA, are equal, as also the angles AZD, DAB; therefore the triangles ZAD, ADB are similar.

Therefore $BD : DA = DA : AZ$,

And $DA^2 = BD \times AZ$;

Therefore $BF^2 = AF \times AZ = AF \times 4AC$.

Therefore a parabola, of which AF is a diameter, and AZ its parameter, will pass through B, and this parabola will be the path of the shell projected as already mentioned.

Remark. When BD cuts this circle, it cuts it in two points D, d ; and there are two directions which will solve the problem. If B'D' only touches the circle in D', there is but one direction, and AB' is the greatest possible range with this velocity. If the vertical line through B does not meet the circle, the problem is impossible, the velocity being too small. When B'D' touches the circle, the two directions AD' and A'd' coalesce into one direction, producing the greatest range, and bisecting the angle ZAB; and the other two directions AD, A'd, producing the same range AB, are equidistant from AD', agreeably to the general proposition.

It is evident that $AZ : AD = S, ADZ : S, AZD = S, DBA : S, DAB = S, p : S, e$

And $AD : DB = S, DBA : S, DAB = S, p : S, e$

And $DB : AB = S, DAB : S, ADB = S, e : S, z$

Therefore $AZ : AB = S^2, p \times S, e : S^2, e \times S, z = S^2, p : S, e \times S, z$

Or $4b : r = S^2, p : S, e \times S, z$, and $4b \times S, e \times S, z = r \times S^2, p$

Hence we obtain the relations wanted.

Thus $b = \frac{r \times S^2, p}{4S, e \times S, z}$, and $r = \frac{4b \times S, e \times S, z}{S^2, p}$

And $S, z = \frac{r \times S^2, p}{4b \times S, e}$, and $S, e = \frac{r \times S^2, p}{4b \times S, z}$

26
To calculate the time of flight.

The only other circumstance in which we are interested is the time of the flight. A knowledge of this is necessary for the bombardier, that he may cut the fuzes of his shells to such lengths as that they may burst at the very instant of their hitting the mark.

Now $AB : DB = \sin, ADB : \sin, DAB = S, z : S, e$, and $DB = \frac{r \times S, e}{S, z}$. But the time of the flight is

the same with the time of falling through DB, and 16 feet : $DB = 1'' : t'^2$. Hence $t'^2 = \frac{r \times S, e}{16S, z}$, and we have

the following easy rule.

From the sum of the logarithms of the range, and of the sine of elevation, subtract the sum of the logarithms of 16, and of the sine of the zenith distance, half the remainder is the logarithm of the time in seconds.

VOL. XV. Part II.

This becomes still easier in practice; for the mortar should be so elevated that the range is a maximum: in which case $AB = DB$, and then half the difference of the logarithms of AB and of 16 is the logarithm of the time in seconds.

Such are the deductions from the general propositions which constitute the ordinary theory of gunnery. It remains to compare them with experiment.

27
The theory compared with experiment.

In such experiments as can be performed with great accuracy in a chamber, the coincidence is as great as can be wished. A jet of water, or mercury, gives us the finest example, because we have the whole parabola exhibited to us in the simultaneous places of the succeeding particles. Yet even in these experiments a deviation can be observed. When the jet is made on a horizontal plane, and the curve carefully traced on a perpendicular plane held close by it, it is found that the distance between the highest point of the curve and the mark is less than the distance between it and the spout, and that the descending branch of the curve is more perpendicular than the ascending branch. And this difference is more remarkable as the jet is made with greater

greater velocity, and reaches to a greater distance. This is evidently produced by the resistance of the air, which diminishes the velocity, without affecting the gravity of the projectile. It is still more sensible in the motion of bombs. These can be traced through the air by the light of their fuzes; and we see that their highest point is always much nearer to the mark than to the mortar on a horizontal plane.

The greatest horizontal range on this plane should be when the elevation is 45° . It is always found to be much lower.

The ranges on this plane should be as the sines of twice the elevation.

A ball discharged at the elev. 19° 5' ranged 448 yards
at 9. 45 330

It should have ranged by theory 241

The range at an elevation of 45° should be twice the impetus. Mr Robins found that a musket-ball, discharged with the usual allotment of powder, had the velocity of 1700 feet in a second. This requires a fall of 45156 feet, and the range should be 90312, or $17\frac{1}{3}$ miles; whereas it does not much exceed half a mile. A 24 pound ball discharged with 16 pounds of powder should range about 16 miles; whereas it is generally short of 3 miles.

28
This comparison
shows the
deficiency of
the theory.

Such facts show incontrovertibly how deficient the parabolic theory is, and how unfit for directing the practice of the artillerist. A very simple consideration is sufficient for rendering this obvious to the most uninstructed. The resistance of the air to a very light body may greatly exceed its weight. Any one will feel this in trying to move a fan very rapidly through the air; therefore this resistance would occasion a greater deviation from uniform motion than gravity would in *that body*. Its path, therefore, through the air may differ more from a parabola than the parabola itself deviates from the straight line.

It is for such cogent reasons that we presume to say, that the voluminous treatises which have been published on this subject are nothing but ingenious amusements for young mathematicians. Few persons who have been much engaged in the study of mechanical philosophy have misfed this opportunity in the beginning of their studies. The subject is easy. Some property of the parabola occurs, by which they can give a neat and systematic solution of all the questions; and at this time of study it seems a considerable essay of skill. They are tempted to write a book on the subject; and it finds readers among other young mechanicians, and employs all the mathematical knowledge that most of the young gentlemen of the military profession are possessed of. But these performances deserve little attention from the practical artillerist. All that seems possible to do for his education is, to multiply judicious experiments on real pieces of ordnance, with the charges that are used in actual service, and to furnish him with tables calculated from such experiments.

These observations will serve to justify us for having given so concise an account of this doctrine of the parabolic flight of bodies.

29
Causes of
this deficiency.

But it is the business of a philosopher to inquire into the causes of such a prodigious deviation from a well founded theory, and having discovered them, to ascertain precisely the deviations they occasion. Thus we shall obtain another theory, either in the form of the parabolic

theory corrected, or as a subject of independent discussion. This we shall now attempt.

The motion of projectiles is performed in the atmosphere. The air is displaced, or put in motion. Whatever motion it acquires must be taken from the bullet. The motion communicated to the air must be in the proportion of the quantity of air put in motion, and of the velocity communicated to it. If, therefore, the displaced air be always *similarly displaced*, whatever be the velocity of the bullet, the motion communicated to it, and lost by the bullet, must be proportional to the square of the velocity of the bullet and to the density of the air jointly. Therefore the diminution of its motion must be greater when the motion itself is greater, and in the very great velocity of shot and shells it must be prodigious. It appears from Mr Robins's experiments that a globe of $4\frac{1}{2}$ inches in diameter, moving with the velocity of 25 feet in a second, sustained a resistance of 315 grains, nearly $\frac{1}{3}$ of an ounce. Suppose this ball to move 800 feet in a second, that is 32 times faster, its resistance would be 32×32 times $\frac{1}{3}$ of an ounce, or 768 ounces or 48 pounds. This is four times the weight of a ball of cast iron of this diameter; and if the initial velocity had been 1600 feet per second, the resistance would be at least 16 times the weight of the ball. It is indeed much greater than this.

This resistance, operating constantly and uniformly on the ball, must take away four times as much from its velocity as its gravity would do in the same time. We know that in one second gravity would reduce the velocity 800 to 768 if the ball were projected straight upwards. This resistance of the air would therefore reduce it in one second to 672, if it operated uniformly; but as the velocity diminishes continually by the resistance, and the resistance diminishes along with the velocity, the real diminution will be somewhat less than 128 feet. We shall, however, see afterwards that in one second its velocity will be reduced from 800 to 687. From this simple instance, we see that the resistance of the air must occasion great deviation from parabolic motion.

In order to judge accurately of its effect, we must consider it as a retarding force, in the same way as we consider gravity. The weight W of a body is the aggregate of the action of the force of gravity g on each particle of the body. Suppose the number of equal particles, or the quantity of matter, of a body to be M , then W is equivalent to gM . In like manner, the resistance R , which we observe in any experiment, is the aggregate of the action of a retarding force R' on each particle, and is equivalent to $R'M$: and as g is equal to $\frac{W}{M}$, so R' is equal to $\frac{R}{M}$. We shall keep this distinction in view, by adding the differential mark ' to the letter R or r , which expresses the aggregate resistance.

If we, in this manner, consider resistance as a retarding force, we can compare it with any other such force by means of the retardation which it produces in similar circumstances. We would compare it with gravity by comparing the diminution of velocity which its uniform action produces in a given time with the diminution produced in the same time by gravity. But we have no opportunity of doing this directly; for when the resistance of the air diminishes the velocity of a body, it diminishes it gradually, which occasions a gradual diminution of its

30
Effect of
the atmosphere
on the bullet.

31
Compared
with that
of gravity.

32
And considered
as a
retarding
force.

33
The resistance
of the air
not uniform.

own intensity. This is not the case with gravity, which has the same action on a body in motion or at rest. We cannot, therefore, observe the uniform action of the air's resistance as a retarding force. We must fall on some other way of making the comparison. We can state them both as dead pressures. A ball may be fitted to the rod of a spring stilleyard, and exposed to the impulse of the wind. This will compress the stilleyard to the mark 3, for instance. Perhaps the weight of the ball will compress it to the mark 6. We know that half this weight would compress it to 3. We account this equal to the pressure of the air, because they balance the same elasticity of the spring. And in this way we can estimate the resistance by weights, whose pressures are equal to its pressure, and we can thus compare it with other resistances, weights, or any other pressures. In fact, we are measuring them all by the elasticity of the spring. This elasticity in its different positions is supposed to have the proportions of the weights which keep it in these positions. Thus we reason from the nature of gravity, no longer considered as a dead pressure, but as a retarding force; and we apply our conclusions to resistances which exhibit the same pressures, but which we cannot make to act uniformly. This sense of the words must be carefully remembered whenever we speak of resistances in pounds and ounces.

The most direct and convenient way of stating the comparison between the resistance of the air and the accelerating force of gravity, is to take a case in which we know that they are equal. Since the resistance is here assumed as proportional to the square of the velocity, it is evident that the velocity may be so increased that the resistance shall equal or exceed the weight of the body. If a body be already moving downwards with this velocity, it cannot accelerate; because the accelerating force of gravity is balanced by an equal retarding force of resistance. It follows from this remark, that this velocity is the greatest that a body can acquire by the force of gravity only. Nay, we shall afterwards see that it never can completely attain it; because as it approaches to this velocity, the remaining accelerating force decreases faster than the velocity increases. It may therefore be called the limiting or **TERMINAL** velocity by gravity.

Let a be the height through which a heavy body must fall, in vacuo, to acquire its terminal velocity in air. If projected directly upwards with this velocity, it will rise again to this height, and the height is half the space which it would describe uniformly, with this velocity, in the time of its ascent. Therefore the resistance to this velocity being equal to the weight of the body, it would extinguish this velocity, by its *uniform* action, in the same time, and after the same distance, that gravity would.

Now let g be the velocity which gravity generates or extinguishes during an unit of time, and let u be the terminal velocity of any particular body. The theorems for perpendicular ascents give us $g = \frac{u^2}{2a}$, u and a being both numbers representing units of space; therefore, in the present case, we have $r = \frac{u^2}{2a}$. For the whole resistance r , or $r'M$, is supposed equal to the weight, or to gM ; and therefore r' is equal to g , $= \frac{u^2}{2a}$ and $2a =$

$\frac{u^2}{g}$. There is a consideration which ought to have place here. A body descends in air, not by the whole of its weight, but by the excess of its weight above that of the air which it displaces. It descends by its *specific* gravity only as a stone does in water. Suppose a body 32 times heavier than air, it will be buoyed up by

a force equal to $\frac{1}{32}$ of its weight; and instead of acquiring the velocity of 32 feet in a second, it will only acquire a velocity of 31, even though it sustained no resistance from the *inertia* of the air. Let p be the weight of the body and π that of an equal bulk of air: the accelerative force of relative gravity on each particle

will be $g \times 1 - \frac{\pi}{p}$; and this relative accelerating force might be distinguished by another symbol γ . But in all cases in which we have any interest, and particular-

ly in military projectiles, $\frac{\pi}{p}$ is so small a quantity that it would be pedantic affectation to attend to it. It is much more than compensated when we make $g = 32$ feet instead of $32\frac{1}{32}$ which it should be.

Let e be the time of this ascent in opposition to gravity. The same theorems give us $eu = 2a$; and since the resistance competent to this terminal velocity is equal to gravity, e will also be the time in which it would be extinguished by the uniform action of the resistance; for which reason we may call it the extinguishing time for this velocity. Let R and E mark the resistance and extinguishing time for the same body moving with the velocity 1.

Since the resistances are as the squares of the velocities, and the resistance to the velocity u is $\frac{u^2}{2a}$, R will be $= \frac{1}{2a}$. Moreover, the times in which the same velocity will be extinguished by different forces, acting uniformly, are inversely as the forces, and gravity would extinguish the velocity 1 in the time $\frac{1}{g} =$ (in these measures) to $\frac{1}{u^2} = \frac{2a}{u^2}$. Therefore we have the following proportion $\frac{1}{2a} (=R) : \frac{u^2}{2a} (=g) = \frac{2a}{u^2} : 2a$, and $2a$ is equal to

E , the time in which the velocity 1 will be extinguished by the uniform action of the resistance competent to this velocity.

The velocity 1 would in this case be extinguished after a motion uniformly retarded, in which the space described is one-half of what would be uniformly described during the same time with the constant velocity 1. Therefore the space thus described by a motion which begins with the velocity 1, and is uniformly retarded by the resistance competent to this velocity, is equal to the height through which this body must fall in *vacuo* in order to acquire its terminal velocity in air.

All these circumstances may be conceived in a manner which, to some readers, will be more familiar and palpable. The terminal velocity is that where the resistance of the air balances and is equal to the weight of the body. The resistance of the air to any particular body is as the square of the velocity; therefore let R be the whole resistance to the body moving with the velocity

3 Z 2 1, and

34
Gravity
and resist-
ance com-
pared when
they are
equal.

1, and r the resistance to its motion with the terminal velocity u ; we must have $r = R \times u^2$, and this must be $= W$ the weight. Therefore, to obtain the terminal velocity, divide the weight by the resistance to the velocity 1, and the quotient is the square of the terminal velocity, or $\frac{W}{R} = u^2$: And this is a very expeditious method of determining it, if R be previously known.

Then the common theorems give a , the fall necessary for producing this velocity in *vacuo* $= \frac{u^2}{2g}$, and the time of the fall $= \frac{u}{g} = e$, and $eu = 2a$, $=$ the space uniformly described with the velocity u during the time of the fall, or its equal, the time of the extinction by the uniform action of the resistance r ; and, since r extinguishes it in the time e , R , which is u^2 times smaller, will extinguish it in the time $u^2 e$, and R will extinguish the velocity 1, which is u times less than u , in the time ue , that is, in the time $2a$; and the body, moving uniformly during the time $2a$, $= E$, with the velocity 1, will describe the space $2a$; and, if the body begin to move with the velocity 1, and be uniformly opposed by the resistance R , it will be brought to rest when it has described the space a ; and the space in which the resistance to the velocity 1 will extinguish that velocity by its uniform action, is equal to the height through which that body must fall in *vacuo* in order to acquire its terminal velocity in air. And thus every thing is regulated by the time E in which the velocity 1 is extinguished by the uniform action of the corresponding resistance, or by $2a$, which is the space uniformly described during this time, with the velocity 1. And E and $2a$ must be expressed by the same number. It is a number of units, of time, or of length.

35
The comparison made general.

Having ascertained these leading circumstances for an unit of velocity, weight, and bulk, we proceed to deduce the similar circumstances for any other magnitude; and, to avoid unnecessary complications, we shall always suppose the bodies to be spheres, differing only in diameter and density.

First, then, let the velocity be increased in the ratio of 1 to v .

The resistance will now be $\frac{v^2}{2a} = r$.

The extinguishing time will be $\frac{E}{v} = e$, $= \frac{2a}{v}$, and $ev = 2a$; so that the rule is general, that the space along which any velocity will be extinguished by the uniform action of the corresponding resistance, is equal to the height necessary for communicating the terminal velocity to that body by gravity. For ev is twice the space through which the body moves while the velocity v is extinguished by the uniform resistance.

In the 2d place, let the diameter increase in the proportion of 1 to d . The aggregate of the resistance changes in the proportion of the surface similarly resisted, that is, in the proportion of 1 to d^2 . But the quantity of matter, or number of particles among which this resistance is to be distributed, changes in the proportion of 1 to d^3 . Therefore the retarding power of the resistance changes in the proportion of 1 to $\frac{1}{d}$. When the diameter was 1, the resistance to a velocity 1 was $\frac{1}{2a}$. It must now

be $\frac{1}{2ad}$. The time in which this diminished resistance will extinguish the velocity 1 must increase in the proportion of the diminution of force, and must now be Ed , or $2ad$, and the space uniformly described during this time with the initial velocity 1 must be $2ad$; and this must still be twice the height necessary for communicating the terminal velocity w to this body.

We must still have $g = \frac{w^2}{2ad}$; and therefore $w^2 = 2gad$, and $w = \sqrt{2gad}$, $= \sqrt{2ga} \sqrt{d}$. But $u = \sqrt{2ga}$. Therefore the terminal velocity w for this body is $= u \sqrt{d}$; and the height necessary for communicating it is ad . Therefore the terminal velocity varies in the subduplicate ratio of the diameter of the ball, and the fall necessary for producing it varies in the simple ratio of the diameter. The extinguishing time for the velocity v must now be $\frac{Ed}{v}$.

If, in the 3d place, the density of the ball be increased in the proportion of 1 to m , the number of particles among which the resistance is to be distributed is increased in the same proportion, and therefore the retarding force of the resistance is equally diminished; and if the density of the air is increased in the proportion of 1 to n , the retarding force of the resistance increases in the same proportion: hence we easily deduce these general expressions.

The terminal velocity $= u \sqrt{d \frac{m}{n}} = \sqrt{2gad \frac{m}{n}}$.

The producing fall in *vacuo* $= ad \frac{m}{n}$.

The retarding power of resistance to any velocity $=$

$$r' = \frac{v^2}{2ad \frac{m}{n}}.$$

The extinguishing time for any velocity $v = \frac{Edm}{vn}$.

And thus we see that the chief circumstances are regulated by the terminal velocity, or are conveniently referred to it.

To render the deductions from these premises perspicuous, and for communicating distinct notions or ideas, it will be proper to assume some convenient units, by which all these quantities may be measured; and, as this subject is chiefly interesting in the case of military projectiles, we shall adapt our units to this purpose. Therefore, let a second be the unit of time, a foot the unit of space and velocity, an inch the unit of diameter of a ball or shell, and a pound avoirdupois the unit of pressure, whether of weight or of resistance; therefore g is 32 feet.

The great difficulty is to procure an absolute measure of r , or u , or a ; any one of these will determine the others.

Sir Isaac Newton has attempted to determine r by theory, and employs a great part of the second book of the *Principia* in demonstrating, that the resistance to a sphere moving with any velocity is to the force which would generate or destroy its whole motion in the time that it would uniformly move over $\frac{1}{3}$ of its diameter with this velocity as the density of the air is to the density of the sphere. This is equivalent to demonstrating that the resistance of the air to a sphere moving through it with any velocity, is equal to half the weight of a column

36

Unitary necessity, by which the quantities may be measured.

37

Sir Isaac Newton's endeavours in this way.

column of air having a great circle of the sphere for its base, and for its altitude the height from which a body must fall in *vacuo* to acquire this velocity. This appears from Newton's demonstration; for, let the specific gravity of the air be to that of the ball as 1 to m ; then, because the times in which the same velocity will be extinguished by the uniform action of different forces are inversely as the forces, the resistance to this velocity would extinguish it in the time of describing $\frac{a}{2} m d$, d being the diameter of the ball. Now 1 is to m as the weight of the displaced air to the weight of the ball, or as $\frac{1}{2}$ of the diameter of the ball to the length of a column of air of equal weight. Call this length a ; a is therefore equal to $\frac{1}{2} m d$. Suppose the ball to fall from the height a in the time t , and acquire the velocity u . If it moved uniformly with this velocity during this time, it would describe a space $= 2a$, or $\frac{4}{3} m d$. Now its weight would extinguish this velocity, or destroy this motion, in the same time, that is, in the time of describing $\frac{4}{3} m d$; but the resistance of the air would do this in the time of describing $\frac{8}{3} m d$; that is, in twice the time. The resistance therefore is equal to half the weight of the ball, or to half the weight of the column of air whose height is the height producing the velocity. But the resistances to different velocities are as the squares of the velocities; and therefore, as their producing heights, and, in general, the resistance of the air to a sphere moving with any velocity, is equal to the half weight of a column of air of equal section, and whose altitude is the height producing the velocity. The result of this investigation has been acquiesced in by all Sir Isaac Newton's commentators. Many faults have indeed been found with his reasoning, and even with his principles; and it must be acknowledged that although this investigation is by far the most ingenious of any in the *Principia*, and sets his acuteness and address in the most conspicuous light, his reasoning is liable to serious objections, which his most ingenious commentators have not completely removed. However, the conclusion has been acquiesced in, as we have already stated, but as if derived from other principles, or by more logical reasoning. We cannot, however, say that the reasonings or assumptions of these mathematicians are much better than Newton's: and we must add, that all the causes of deviation from the duplicate ratio of the velocities, and the causes of increased resistance, which the later authors have valued themselves for discovering and introducing into their investigations, were pointed out by Sir Isaac Newton, but purposely omitted by him, in order to facilitate the discussion in *re difficillima*. (See *Schol. prop. 37. b. ii.*)

It is known that the weight of a cubic foot of water is 62½ pounds, and that the medium density of the air is $\frac{1}{840}$ of water; therefore let a be the height producing the velocity (in feet), and d the diameter of the ball (in inches), and π the periphery of a circle whose diameter is 1; the resistance of the air will be $= \frac{62\frac{1}{2}}{840} \times \frac{\pi}{4}$

$$\times \frac{1}{144} \times \frac{a}{2} \times d^2 = \frac{a d^2}{4928\frac{1}{2}} \text{ pounds, very nearly, } = \frac{4928\frac{1}{2} \times 64}{315417} d^2 = \frac{a d^2}{315417} \text{ pounds.}$$

We may take an example. A ball of cast iron weighing 12 pounds, is 4½ inches in diameter. Suppose this

ball to move at the rate of 25 $\frac{1}{8}$ feet in a second (the reason of this choice will appear afterwards). The height which will produce this velocity in a falling body is 9½ feet. The area of its great circle is 0,11044 feet, or $\frac{1}{88044}$ of one foot. Suppose water to be 840 times heavier than air, the weight of the air incumbent on this great circle, and 9½ feet high, is 0,081151 pounds: half of this is 0,0405755 or $\frac{1}{24608}$ of a pound. This should be the resistance of the air to this motion of the ball.

In all matters of physical discussion, it is prudent to confront every theoretical conclusion with experiment. This is particularly necessary in the present instance, because the theory on which this proposition is founded is extremely uncertain. Newton speaks of it with the most cautious diffidence, and secures the justness of the conclusions by the conditions which he assumes in his investigation. He describes with the greatest precision the state of the fluid in which the body must move, so as that the demonstrations may be strict, and leaves it to others to pronounce whether this is the real constitution of our atmosphere. It must be granted that it is not; and that many other suppositions have been introduced by his commentators and followers, in order to suit his investigation (for we must assert that little or nothing has been added to it) to the circumstances of the case.

Newton himself, therefore, attempted to compare his propositions with experiment. Some were made by dropping balls from the dome of St Paul's cathedral; and all these showed as great a coincidence with his theory as they did with each other: but the irregularities were too great to allow him to say with precision what was the resistance. It appeared to follow the proportion of the squares of the velocities with sufficient exactness; and though he could not say that the resistance was equal to the weight of the column of air having the height necessary for communicating the velocity, it was always equal to a determinate part of it; and might be stated $= na$, n being a number to be fixed by numerous experiments.

One great source of uncertainty in his experiments seems to have escaped his observation: the air in that dome is almost always in a state of motion. In the summer season there is a very sensible current of air downwards, and frequently in winter it is upwards: and this current bears a very great proportion to the velocity of the descents. Sir Isaac takes no notice of this.

He made another set of experiments with pendulums; and has pointed out some very curious and unexpected circumstances of their motions in a resisting medium. There is hardly any part of his noble work in which his address, his patience, and his astonishing penetration, appear in greater lustre. It requires the utmost intenseness of thought to follow him in these disquisitions; and we cannot enter on the subject at present: some notice will be taken of these experiments in the article *RESISTANCE of Fluids*. Their results were much more uniform, and confirmed his general theory; and, as we have said above, it has been acquiesced in by the first mathematicians of Europe.

But the deductions from this theory were so inconsistent with the observed motions of military projectiles, when the velocities are prodigious, that no application could be made which could be of any service for determining

33
His result
just, but
his reason-
ing errone-
ous.

32
Necessity
of experi-
ment.

43
Newton's
experi-
ments.

44

45
Inutility of
the theory
in practice.

42
The at-
tempts of
various
mathemati-
cians, &c.

mining the path and motion of cannon shot and bombs; and although Mr John Bernoulli gave in 1718 a most elegant determination of the trajectory and motion of a body projected in a fluid which resists in the duplicate ratio of the velocities (a problem which even Newton did not attempt), it has remained a dead letter. Mr Benjamin Robins, equally eminent for physical science and mathematical genius, was the first who suspected the true cause of the imperfection of the usually received theories; and in 1737 he published a small tract, in which he showed clearly, that even the Newtonian theory of resistance must cause a cannon ball, discharged with a full allotment of powder, to deviate farther from the parabola, in which it would move *in vacuo*, than the parabola deviates from a straight line. But he farther asserted, on the authority of good reasoning, that in such great velocities the resistance must be much greater than this theory assigns; because, besides the resistance arising from the *inertia* of the air which is put in motion by the ball, there must be a resistance arising from a condensation of the air on the anterior surface of the ball, and a rarefaction behind it; and there must be a third resistance, arising from the local pressure of the air on its anterior part, *as the motion is so swift that there is a vacuum behind.* Even these causes of disagreement with the theory had been foreseen and mentioned by Newton (see the Scholium to prop. 37, Book II. *Princip.*); but the subject seems to have been little attended to. The eminent mathematicians had few opportunities of making experiments; and the professional men, who were in the service of princes, and had their countenance and aid in this matter, were generally too deficient in mathematical knowledge to make a proper use of their opportunities. The numerous and splendid volumes which these gentlemen have been enabled to publish by the patronage of sovereigns are little more than prolix extensions of the simple theory of Galileo. Some of them, however, such as St Remy, Antonini, and Le Blond, have given most valuable collections of experiments, ready for the use of the profound mathematician.

43
Observa-
tions of Mr
Robins on
velocity
and resist-
ance,

Two or three years after this first publication, Mr Robins hit upon that ingenious method of measuring the great velocities of military projectiles, which has handed down his name to posterity with great honour. And having ascertained these velocities, he discovered the prodigious resistance of the air, by observing the diminution of velocity which it occasioned. This made him anxious to examine what was the real resistance to any velocity whatever, in order to ascertain what was the law of its variation; and he was equally fortunate in this attempt. His method of measuring the resistance has been fully described in the article GUNNERY, n^o 9, &c.

It appears (Robins's *Math. Works*, vol. i. page 205.) that a sphere of $4\frac{1}{2}$ inches in diameter, moving at the rate of $25\frac{1}{2}$ feet in a second, sustained a resistance of 0.04914 pounds, or $\frac{4914}{100000}$ of a pound. This is a greater resistance than that of the Newtonian theory, which gave $\frac{400000000}{1000000000}$ in the proportion of 1000 to 1211, or very nearly in the proportion of five to six in small numbers. And we may adopt as a rule in all moderate velocities, that the resistance to a sphere is equal to $\frac{6}{100}$ of the weight of a column of air having the great circle of the sphere for its base, and for its altitude the height through which a heavy body must fall *in vacuo* to acquire the velocity of projection.

This experiment is peculiarly valuable, because the ball is precisely the size of a 12 pound shot of cast iron; and its accuracy may be depended on. There is but one source of error. The whirling motion must have occasioned some whirl in the air, which would continue till the ball again passed through the same point of its revolution. The resistance observed is therefore probably somewhat less than the true resistance to the velocity of $25\frac{1}{2}$ feet, because it was exerted in a relative velocity which was less than this, and is, in fact, the resistance competent to this relative and smaller velocity.

44
—Accordingly, Mr Smeaton, a most sagacious natu- And of Mr
ralist, places great confidence in the observations of a Rouse and
Mr Rouse of Leicestershire, who measured the resistance De Borda.
by the effect of the wind on a plane properly exposed to it. He does not tell us in what way the velocity of the wind was ascertained; but our deference for his great penetration and experience disposes us to believe that this point was well determined. The resistance observed by Mr Rouse exceeds that resulting from Mr Robins's experiments nearly in the proportion of 7 to 10. 45
Chevalier de Borda made experiments similar to those They differ
of Mr Robins, and his results exceed those of Robins widely in
in the proportion of 5 to 6. These differences their con-
are so considerable, that we are at a loss what measure clusions.
to abide by. It is much to be regretted, that in a subject so interesting both to the philosopher and the man of the world, experiments have not been multiplied. Nothing would tend so much to perfect the science of gunnery; and indeed till this be done, all the labours of mathematicians are of no avail. Their investigations must remain an unintelligible cipher, till this key be supplied. It is to be hoped that Dr Charles Hutton of Woolwich, who has so ably extended Mr Robins's Examination of the Initial Velocities of Military Projectiles, will be encouraged to proceed to this part of the subject. We should wish to see, in the first place, a numerous set of experiments for ascertaining the resistances in moderate velocities; and, in order to avoid all error from the resistance and inertia of the machine, which is necessarily blended with the resistance of the ball, in Mr Robins's form of the experiment, and is separated with great uncertainty and risk of error, we would recommend a form of experiment somewhat different.

46
Let the axis and arm which carries the ball be con- A new form
nected with wheelwork, by which it can be put in mo- of experi-
tion, and gradually accelerated. Let the ball be so ment re-
connected with a bent spring, that this shall gradually ed. commend-
compress it as the resistance increases, and leave a mark of the degree of compression; and let all this part of the apparatus be screened from the air except the ball. The velocity will be determined precisely by the revolutions of the arm, and the resistance by the compression of the spring. The best method would be to let this part of the apparatus be made to slide along the revolving arm, so that the ball can be made to describe larger and larger circles. An intelligent mechanician will easily contrive an apparatus of this kind, held at any distance from the axis by a cord, which passes over a pulley in the axis itself, and is then brought along a perforation in the axis, and comes out at its extremity, where it is fitted with a swivel, to prevent it from snapping by being twisted. Now let the machine be put in motion. The centrifugal force of the ball and apparatus will cause it to fly out as far as it is allowed by the cord; and

and if the whole is put in motion by connecting it with some mill, the velocity may be most accurately ascertained. It may also be fitted with a bell and hammer like Gravefande's machine for measuring centrifugal forces. Now by gradually veering off more cord, the distance from the centre, and consequently the velocity and resistance increase, till the hammer is disengaged and strikes the bell.

Another great advantage of this form of the experiment is, that the resistance to very great velocities may be thus examined, which was impossible in Mr Robins's way. This is the great desideratum, that we may learn in what proportion of the velocities the resistances increase.

In the same manner, an apparatus, consisting of Dr Lynd's Anemometer, described in the article PNEUMATICS, n° 311, &c. might be whirled round with prodigious rapidity, and the fluid on it might be made clammy, which would leave a mark at its greatest elevation, and thus discover the resistance of the air to rapid motions.

Nay, we are of opinion that the resistance to very rapid motions may be measured directly in the conduit pipe of some of the great cylinder bellows employed in blast furnaces: the velocity of the air in this pipe is ascertained by the capacity of the cylinder and the strokes of the piston. We think it our duty to point out to such as have the opportunities of trying them methods which promise accurate results for ascertaining this most desirable point.

⁴⁷ The result of Robins's experiments as yet most to be depended on. We are the more puzzled what measure to abide by, because Mr Robins himself, in his Practical Propositions, does not make use of the result of his own experiments, but takes a much lower measure. We must content ourselves, however, with this experimental measure, because it is as yet the only one of which any account can be given, or well-founded opinion formed.

⁴⁸ Applied to the formulae. Therefore, in order to apply our formulæ, we must reduce this experiment, which was made on a ball of $4\frac{1}{2}$ inches diameter, moving with the velocity of $25\frac{1}{2}$ feet per second, to what would be the resistance to a ball of one inch, having the velocity 1 foot. This will evidently give us $R = \frac{0,04914}{4,5^2 \times 25,2^2}$, being diminished in the duplicate ratio of the diameter and velocity. This gives us $R = 0,00000381973$ pounds, or $\frac{3,81973}{1000000}$ of a pound. The logarithm is 4,58204. The resistance here determined is the same whatever substance the ball be of; but the retardation occasioned by it will depend on the proportion of the resistance to the *vis inertia* of the ball; that is, to its quantity of motion. This in similar velocities and diameters is as the density of the ball. The balls used in military service are of cast iron or of lead, whose specific gravities are 7,207 and 11,37 nearly, water being 1. There is considerable variety in cast iron, and this density is about the medium. These data will give us

	For Iron.	For Lead.
W, or weight of a ball 1 inch in diameter	lbs. 0,13648	0,21533
Log. of W	9,13509	9,33310
E''	1116'',6	1761'',6
Log. of E	3,04790	3,24591
u, or terminal velocity	189,03	237,43
Log. u	2,27653	2,37553
a, or producing height	558,3	88c,8

These numbers are of frequent use in all questions on this subject.

Mr Robins gives an expeditious rule for readily finding *a*, which he calls *F* (see the article GUNNERY), by which it is made 900 feet for a cast iron ball of an inch diameter. But no theory of resistance which he professes to use will make this height necessary for producing the terminal velocity. His *F* therefore is an *empirical* quantity, analogous indeed to the producing height, but accommodated to his theory of the trajectory of cannon-shot, which he promised to publish, but did not live to execute. We need not be very anxious about this; for all our quantities change in the same proportion with *R*, and need only a correction by a multiplier or divisor, when *R* shall be accurately established.

We may illustrate the use of these formulæ by an example or two.

1. Then, to find the resistance to a 24 pound ball⁴⁹ moving with the velocity of 1670 feet in a second, of their which is nearly the velocity communicated by 16 lbs. of powder. The diameter is $5,603$ inches.

Log. R	-	-	+4,58204
Log. <i>d</i> ²	-	-	+1,49674
Log. 1670 ²	-	-	+6,44548

Log. 334,4 lbs. = *r* - 2,52426

But it is found, by unequivocal experiments on the retardation of such a motion, that it is 504 lbs. This is owing to the causes often mentioned, the additional resistance to great velocities, arising from the condensation of the air, and from its pressure into the vacuum left by the ball.

2. Required the terminal velocity of this ball?

Log. R	-	-	+4,58204
Log. <i>d</i> ²	-	-	+1,49674

Log. resist. to veloc. 1	-	6,07878 = <i>a</i>
Log. W	-	1,38021 = <i>b</i>
Diff. of <i>a</i> and <i>b</i> , = log <i>u</i> ²	-	5,30143
Log. 447,4 = <i>u</i>	-	2,65071

As the terminal velocity *u*, and its producing height ⁵⁰ Table of *a*, enter into all computations of military projectiles, we have inserted the following Table for the usual sizes of cannon-shot, computed both by the Newtonian theory of resistance, and by the resistances observed in Robins's experiments.

Lb. Ball.	Newton.		Robins.		Diam. Inch.
	Term. Vel.	2 <i>a</i> .	Term. Vel.	2 <i>a</i> .	
1	289,9	2626,4	263,4	2168,6	1,94
2	324,9	3298,5	295,2	2723,5	2,45
3	348,2	3788,2	316,4	3127,9	2,80
4	365,3	4170,3	331,9	3442,6	3,08
6	390,8	4472,7	355,1	3940,7	3,52
9	418,1	5463,5	379,9	4511,2	4,04
12	438,6	6010,6	398,5	4962,9	4,45
18	469,3	6883,3	426,5	5683,5	5,09
24	492,4	7576,3	447,4	6255,7	5,61
32	512,6	8024,8	465,8	6780,4	6,21
	540,5	9129,9	491,5	7538,3	6,75

Mr Muller, in his writings on this subject, gives a much

51
Mr Muller's theory
altogether
erroneous.

much smaller measure of resistance, and consequently a much greater terminal velocity: but his theory is a mistake from beginning to end (See his *Supplement* to his *Treatise of Artillery*, art. 150, &c.) In art. 148. he assumes an algebraic expression for a principle of mechanical argument; and from its consequence draws erroneous conclusions. He makes the resistance of a cylinder $\frac{1}{2}$ less than Newton *supposes* it; and his reason is false. Newton's measure is demonstrated by his commentators Le Seur and Jaquier to be even a little too small, upon his own principles, (Not. 277. Prop. 36. B. II.) Mr Muller then, without any seeming reason, introduces a new principle, which he makes the chief support of his theory, in opposition to the theories of other mathematicians. The principle is false, and even absurd, as we shall have occasion to show by and by. In consequence, however, of this principle, he is enabled to compare the results with many experiments, and the agreement is very flattering. But we shall soon see that little dependence can be had on such comparisons. We notice these things here, because Mr Muller being head of the artillery school in Britain, his publications have become a sort of text-book. We are miserably deficient in works on this subject, and must have recourse to the foreign writers.

52
The motions considered through their whole course.

We now proceed to consider these motions through their whole course: and we shall first consider them as affected by the resistance only; then we shall consider the perpendicular ascents and descents of heavy bodies through the air; and, lastly, their motion in a curvilinear trajectory, when projected obliquely. This must be done by the help of the abstruse parts of fluxionary mathematics. To make it more perspicuous, we shall, by way of introduction, consider the simply resisted rectilinear motions geometrically, in the manner of Sir Isaac Newton. As we advance, we shall quit this track, and prosecute it algebraically, having by this time acquired distinct ideas of the algebraic quantities.

53
Preliminary observations.

We must keep in mind the fundamental theorems of varied motions.

1. The momentary variation of the velocity is proportional to the force and the moment of time jointly, and may therefore be represented by $\pm v = f i$, where v is the momentary increment or decrement of the velocity, f the accelerating or retarding force, and i the moment or increment of the time t .

2. The momentary variation of the square of the velocity is as the force, and as the increment or decrement of the space jointly; and may be represented by $\pm v v = f s$. The first proposition is familiarly known. The second is the 39th of Newton's *Principia*, B. I. It is demonstrated in the article OPTICS, p. 281. and is the most extensively useful proposition in mechanics.

54
The motions as affected by resistance only.
Plate
ccccvii.

These things being premised, let the straight line AC (fig. 6.) represent the initial velocity V , and let CO, perpendicular to AC, be the time in which this velocity would be extinguished by the uniform action of the resistance. Draw through the point A an equilateral hyperbola $A e B$, having OF, OCD for its asymptotes; then let the time of the resisted motion be represented by the line CB, C being the first instant of the motion. If there be drawn perpendicular ordinates ae, gf, DB , &c. to the hyperbola, they will be pro-

portional to the velocities of the body at the instants e, g, D , &c. and the hyperbolic areas $AC^x e, AC g f, ACDB$, &c. will be proportional to the spaces described during the times $C^x, C g, CB$, &c.

For, suppose the time divided into an indefinite number of small and equal moments, Cc, Dd , &c. draw the ordinates ac, bd , and the perpendiculars $b\beta, a\alpha$. Then, by the nature of the hyperbola, $AC : ac = Oc : OC$; and $AC - ac : ac = Oc - OC : OC$, that is, $A\alpha : ac = Cc : OC$, and $A\alpha : Cc = ac : OC = AC : ac$; $AC : OC$; in like manner, $B\beta : Dd = BD : bD : BD : OD$. Now $Dd = Cc$, because the moments of time were taken equal, and the rectangles $AC \cdot CO, BD \cdot DO$, are equal, by the nature of the hyperbola; therefore $A\alpha : B\beta = AC : ac : BD : bd$; but as the points c, d continually approach, and ultimately coincide with C, D , the ultimate ratio of $AC : ac$ to $BD : bd$ is that of AC^2 to BD^2 ; therefore the momentary decrements of AC and BD are as AC^2 and BD^2 . Now, because the resistance is measured by the momentary diminution of velocity, these diminutions are as the squares of the velocities; therefore the ordinates of the hyperbola and the velocities diminish by the same law; and the initial velocity was represented by AC : therefore the velocities at all the other instants e, g, D , are properly represented by the corresponding ordinates. Hence,

1. Since the abscissas of the hyperbola are as the times, and the ordinates are as the velocities, the areas will be as the spaces described, and $AC^x e$ is to $AC g f$ as the space described in the time C^x to the space described in the time $C g$ (1st Theorem on varied motions).

2. The rectangle ACOF is to the area ACDB as the space formerly expressed by $2a$, or E to the space described in the resisting medium during the time CD : for AC being the velocity V , and OC the extinguishing time e , this rectangle is $= eV$, or E , or $2a$, of our former disquisitions; and because all the rectangles, such as ACOF, BDOG, &c. are equal, this corresponds with our former observation, that the space uniformly described with any velocity during the time in which it would be uniformly extinguished by the corresponding resistance is a constant quantity, viz: that in which we always had $e v = E$, or $2a$.

3. Draw the tangent A^x ; then, by the hyperbola $C^x = CO$: now C^x is the time in which the resistance to the velocity AC would extinguish it; for the tangent coinciding with the elemental arc Aa of the curve, the first impulse of the uniform action of the resistance is the same with the first impulse of its varied action. By this the velocity AC is reduced to ac . If this operated uniformly like gravity, the velocities would diminish uniformly, and the space described would be represented by the triangle AC^x .

This triangle, therefore, represents the height through which a heavy body must fall in vacuo, in order to acquire the terminal velocity.

4. The motion of a body resisted in the duplicate ratio of the velocity will continue without end, and a space will be described which is greater than any assignable space, and the velocity will grow less than any that can be assigned; for the hyperbola approaches continually to the asymptote, but never coincides with it. There is no velocity BD so small, but a smaller ZP will be found beyond it; and the hyperbolic space

may

may be continued till it exceeds any surface that can be assigned.

5. The initial velocity AC is to the final velocity BD as the sum of the extinguishing time and the time of the retarded motion, is to the extinguishing time alone: for AC:BD = OD (or OC + CD):OC; or $V:v = e:t$.

6. The extinguishing time is to the time of the retarded motion as the final velocity is to the velocity lost during the retarded motion: for the rectangles AFOC, BDOG are equal; and therefore AVGF and BVCD are equal and VC:VA = VG:VB; therefore $t = e \frac{V-v}{v}$, and $e = t \frac{v}{V-v}$.

7. Any velocity is reduced in the proportion of m to n in the time $e \frac{m-n}{n}$. For, let AC:BD = $m:n$; then DO:CO = $m:n$, and DC:CO = $m-n:n$, and $DC = \frac{m-n}{n} CO$, or $t = e \frac{m-n}{n}$. Therefore any velocity is reduced to one half in the time in which the initial resistance would have extinguished it by its uniform action.

55
A other
mode of
determin-
ing this
motion.

Thus may the chief circumstances of this motion be determined by means of the hyperbola, the ordinates and abscissæ exhibiting the relations of the times and velocities, and the areas exhibiting the relations of both to the spaces described. But we may render the conception of these circumstances infinitely more easy and simple, by expressing them all by lines, instead of this combination of lines and surfaces. We shall accomplish this purpose by constructing another curve LKP, having the line ML, parallel to OD for its abscissa, and of such a nature, that if the ordinates to the hyperbola AC, e , fg , BD, &c. be produced till they cut this curve in L, p , n , K, &c. and the abscissa in L, t , h , s , &c. the ordinates p , bn , K , &c. may be proportional to the hyperbolic areas eAC , fAC , sAC , &c. Let us examine what kind of curve this will be.

Make OC:O \times = O \times :Og; then (Hamilton's *Conics*, IV. 14. Cor.), the areas AC \times e, $e \times gf$ are equal: therefore drawing ps , nt perpendicular to OM, we shall have (by the assumed nature of the curve LpK), Ms = st; and if the abscissa OD be divided into any number of small parts in geometrical progression (reckoning the commencement of them all from O), the axis Vi of this curve will be divided by its ordinates into the same number of equal parts; and this curve will have its ordinates LM, ps , nt , &c. in geometrical progression, and its abscissæ in arithmetical progression.

Also, let KN, MV touch the curve in K and L, and let OC be supposed to be to Oc, as OD to Od, and therefore Cc to Dd as OC to OD; and let these lines Cc, Dd be indefinitely small; then (by the nature of the curve) Lo is equal to Kr: for the areas aACc, bBDd are in this case equal. Also lo is to kr, as LM to KI, because cC:dD = CO:DO:

Therefore IN:IK = rK:rk

IK:ML = rk:ol

ML:MV = ol:ol

and IN:MN = rK:ol.

That is, the subtangent IN, or MV, is of the same magnitude.

VOL. XV. Part II.

itude, or is a constant quantity in every part of the curve.

Lastly, the subtangent IN, corresponding to the point K of the curve, is to the ordinate K ρ as the rectangle BDOG or ACOF to the parabolic area BDCA.

For let $fgbn$ be an ordinate very near to BD ρ K; and let bn cut the curve in n , and the ordinate KI in q ; then we have

Kq:qn = KI:IN, or

Dg:gn = DO:IN;

but BD:AC = CO:DO;

therefore BD.Dg:AC.qn = CO:IN:

Therefore the sum of all the rectangles BD.Dg is to the sum of all the rectangles AC.qn, as CO to IN; but the sum of the rectangles BD.Dg is the space ACDB; and, because AC is given, the sum of the rectangles AC.qn is the rectangle of AC and the sum of all the lines qn; that is, the rectangle of AC and RL: therefore the space ACDB:AC.RL = CO:IN, and ACDB \times IN = AC.CO.RL; and therefore IN:RL = AC.CO:ACDB.

Hence it follows that QL expresses the area BVA, and, in general, that the part of the line parallel to OM, which lies between the tangent KN and the curve LpK, expresses the corresponding area of the hyperbola which lies without the rectangle BDOG.

And now, by the help of this curve, we have an easy way of conceiving and computing the motion of a body through the air. For the subtangent of our curve now represents twice the height through which the ball must fall in vacuo, in order to acquire the terminal velocity; and therefore serves for a scale on which to measure all the other representatives of the motion.

But it remains to make another observation on the curve LpK, which will save us all the trouble of graphical operations, and reduce the whole to a very simple arithmetical computation. It is of such a nature, that when MI is considered as the abscissa, and is

divided into a number of equal parts, and ordinates are drawn from the points of division, the ordinates are a series of lines in geometrical progression, or are continual proportionals. Whatever is the ratio between the first and second ordinate, there is the same between the second and third, between the third and fourth, and so on; therefore the number of parts into which the abscissa is divided is the number of these equal ratios which is contained in the ratio of the first ordinate to the last: For this reason, this curve has got the name of the *logistic* or *logarithmic* curve; and it is of immense use in the modern mathematics, giving us the solution of many problems in the most simple and expeditious manner, on which the genius of the ancient mathematicians had been exercised in vain. Few of our readers are ignorant, that the numbers called *logarithms* are of equal utility in arithmetical operations, enabling us not only to solve common arithmetical problems with astonishing dispatch, but also to solve others which are quite inaccessible in any other way. Logarithms are nothing more than the numerical measures of the abscissa of this curve, corresponding to ordinates, which are measured on the same or any other scale by the natural numbers; that is, if ML be divided into equal parts, and from the points of division lines be drawn parallel to

4 A

MI,

MI, cutting the curve LpK , and from the points of intersection ordinates be drawn to MI, these will divide MI into portions, which are in the same proportion to the ordinates that the logarithms bear to their natural numbers.

In constructing this curve we were limited to no particular length of the line LR, which represented the space ACDB; and all that we had to take care of was, that when OC, O π , O g were taken in geometrical progression, M π , M t should be in arithmetical progression. The abscissæ having ordinates equal to $p\pi$, $n\pi$, &c. might have been twice as long, as is shown in the dotted curve which is drawn through L. All the lines which serve to measure the hyperbolic spaces would then have been doubled. But NI would also have been doubled, and our proportions would have still held good; because this subtangent is the scale of measurement of our figure, as E or $2a$ is the scale of measurement for the motions.

Since then we have tables of logarithms calculated for every number, we may make use of them instead of this geometrical figure, which still requires considerable trouble to suit it to every case. There are two sets of logarithmic tables in common use. One is called a table of hyperbolic or natural logarithms. It is suited to such a curve as is drawn in the figure, where the subtangent is equal to that ordinate τv which corresponds to the side πO of the square $\pi b \lambda O$ inserted between the hyperbola and its asymptotes. This square is the unit of surface, by which the hyperbolic areas are expressed; its side is the unit of length, by which the lines belonging to the hyperbola are expressed; τv is $= 1$, or the unit of numbers to which the logarithms are suited, and then IN is also 1. Now the square $b\pi O$ being unity, the area BACD will be some number; πO being also unity, OD is some number: Call it x . Then, by the nature of the hyperbola, OB : O π = πb : DB: That is, $x : 1 = 1 : \frac{1}{x}$, so that DB is $\frac{1}{x}$.

Now calling Dd π , the area BD db, which is the fluxion (ultimately) of the hyperbolic area, is $\frac{\pi}{x}$. Now

in the curve LpK , MI has the same ratio to NI that BACD has to $b\lambda O\pi$: Therefore, if there be a scale of which NI is the unit, the number on this scale corresponding to MI has the same ratio to 1 which the number measuring BACD has to 1; and Ii, which corresponds to BD db, is the fluxion (ultimately) of MI: Therefore, if MI be called the logarithm of x , $\frac{\pi}{x}$ is properly represented by the fluxion of MI. In short, the line MI is divided precisely as the line of numbers on a Gunter's scale, which is therefore a line of logarithms; and the numbers called logarithms are just the lengths of the different parts of this line measured on a scale of equal parts. Therefore, when

we meet with such an expression as $\frac{\pi}{x}$ viz. the fluxion of a quantity divided by the quantity itself, we consider it as the fluxion of the logarithm of that quantity, because it is really so when the quantity is a number; and it is therefore strictly true that the fluent of $\frac{\pi}{x}$ is the hyperbolic logarithm of x .

Certain reasons of convenience have given rise to another set of logarithms; these are suited to a logistic curve whose subtangent is only $\frac{4.3429}{10000}$ of the ordinate τv , which is equal to the side of the hyperbolic square, and which is assumed for the unit of number. We shall suit our applications of the preceding investigation to both these, and shall first use the common logarithms whose subtangent is 0.43429.

The whole subject will be best illustrated by taking ⁵⁷ an example of the different questions which may be proposed by examples.

Recollect that the rectangle ACOF is $= 2a$, or $\frac{u^2}{g}$ or E, for a ball of cast-iron one inch diameter, and if it has the diameter d , it is $\frac{u^2 d}{g}$, or $2ad$, or E d .

I. It may be required to determine what will be the space described in a given time t by a ball setting out with a given velocity V, and what will be its velocity v at the end of that time.

Here we have NI : MI = ACOF : BDCA; now NI is the subtangent of the logistic curve; MI is the difference between the logarithms of OD and OC; that is, the difference between the logarithms of $e+t$ and e ;

ACOF is $2ad$, or $\frac{u^2 d}{g}$, or E d .

Therefore by common logarithms $0.43429 : \log. e+t - \log. e = 2ad : S$, = space described,

or $0.43429 : \log. \frac{e+t}{e} = 2ad : S$,

and $S = \frac{2ad}{0.43429} \times \log. \frac{e+t}{e}$,

by hyperbolic logarithms $S = 2ad \times \log. \frac{e+t}{e}$.

Let the ball be a 12 pounder, and the initial velocity be 1600 feet, and the time 20 seconds. We must first find e , which is $\frac{2ad}{V}$.

Therefore, log. $2a$	-	-	+ 3.03236
log. d (4, 5)	-	-	+ 0.65321
log. V. (1600)	-	-	- 3.20412

Log. of $3''03 = e$

And $e+t$ is $23''03$, of which the log. is 1.36229
from which take the log. of e 0.48145

remains the log. of $\frac{e+t}{e}$ 0.88084

This must be considered as a common number by which we are to multiply $\frac{2ad}{0.43429}$.

Therefore add the logarithms of $2ad$ + 3.68557

log. $\frac{e+t}{e}$ + 0.88084

log. 0.43429 - 0.63778

Log. S. 9833 feet - 3.99269

For the final velocity,

OD : OC = AC : BD, or $e+t : e = V : v$.

$23''03 : 3''03 = 1600 : 210 \frac{1}{2} = v$.

The ball has therefore gone 3278 yards, and its velocity is reduced from 1600 to 210.

It may be agreeable to the reader to see the gradual progress of the ball during some seconds of its motion.

T.	S.	Diff.	V.	Diff.
1"	1383		1203	397
2"	2456	1073	964	239
3"	3336	880	804	160
4"	4080	744	690	114
5"	4725	645	604	86
6"	5294	569	537	67

The first column is the time of the motion, the second is the space described, the third is the differences of the spaces, showing the motion during each successive second; the fourth column is the velocity at the end of the time t ; and the last column is the differences of velocity, showing its diminution in each successive second. We see that at the distance of 1000 yards the velocity is reduced to one half, and at the distance of less than a mile it is reduced to one third.

II. It may be required to determine the distance at which the initial velocity V is reduced to any other quantity v . This question is solved in the very same manner, by substituting the logarithms of V and v for those of $e+t$ and e ; for $AC : BD = OD : OC$, and therefore $\log. \frac{AC}{BD} = \log. \frac{OD}{OC}$, or $\log. \frac{V}{v} = \log. \frac{e+t}{e}$.

Thus it is required to determine the distance in which the velocity 1780 of a 24 pound ball (which is the medium velocity of such a ball discharged with 16 pounds of powder) will be reduced to 1500.

Here d is 5,68, and therefore the logarithm of $2ad$ is

$$\begin{array}{rcl} \log. \frac{V}{v} = 0,07433, \text{ of which the log. is } & + 8.87116 & \\ \log. 0,43429 & - & -9.63778 \\ \hline \end{array}$$

Log. 1047,3 feet, or 349 yards 3.02009
This reduction will be produced in about $\frac{1}{3}$ of a second.

III. Another question may be to determine the time which a ball, beginning to move with a certain velocity, employs in passing over a given space, and the diminution of velocity which it sustains from the resistance of the air.

We may proceed thus:

$$2ad : S = 0,43429 : \log. \frac{e+t}{e} = t. \text{ Then to log.}$$

$\frac{e+t}{e}$ add log. e and we obtain $\log. e+t$, and $e+t$; from which if we take e we have t . Then to find v , say $e+t : e = V : v$.

38 Application of an experiment of Mr Robins. We shall conclude these examples by applying this last rule to Mr Robins's experiment on a musket bullet of $\frac{1}{4}$ of an inch in diameter, which had its velocity reduced from 1670 to 1425 by passing through 100 feet of air. This we do in order to discover the resistance which it sustained, and compare it with the resistance to a velocity of 1 foot per second.

We must first ascertain the first term of our analogy. The ball was of lead, and therefore $2a$ must be multiplied by d and by m , which expresses the ratio of the density of lead to that of cast iron. d is 0,75, and m is

$$\frac{11,37}{7,21} = 1,577. \text{ Therefore } \log. 2a = 3.03236$$

$$\begin{array}{r} d \ 9.87506 \\ m \ 0.19782 \\ \hline \end{array}$$

$$\log. 2adm = 3.10524$$

$$\text{and } 2adm = 1274,2.$$

$$\text{Now } 1274,2 : 100 = 0,43429 : 0,03408 = \log. \frac{e+t}{e}.$$

But $e = \frac{2adm}{V} = 0,763$, and its logarithm $= 9.88252$, which, added to 0,03408, gives 9,91660, which is the log. of $e+t$, $= 0,825$, from which take e , and there remains $t = 0'',062$, or $\frac{62}{1000}$ of a second, for the time of passage. Now, to find the remaining velocity, say $825 : 763 = 1670 : 1544 = v$.

But in Mr Robins's experiment the remaining velocity was only 1425, the ball having lost 245; whereas by this computation it should have lost only 126. It appears, therefore, that the resistance is double of what it would have been if the resistance increased in the duplicate proportion of the velocity. Mr Robins says it is nearly triple. But he supposes the resistance to flow motions much smaller than his own experiment, so often mentioned, fully warrants.

The time e , in which the resistance of the air would extinguish the velocity is $0'',763$. Gravity, or the weight of the bullet, would have done it in $\frac{1670}{32}$ or 52';

therefore the resistance is $\frac{52}{0,763}$ times, or nearly 68 times its weight, by this theory, or 5,97 pounds. If we calculate from Mr Robins's experiment, we must say $\log. \frac{V}{v} : 0,43429 = 100 : eV$, which will be 630,23, and

$$e = \frac{630,23}{1670} = 0'',3774, \text{ and } \frac{52}{0,3774} \text{ gives 138 for the}$$

proportion of the resistance to the weight, and makes the resistance 12,07 pounds, fully double of the other.

It is to be observed, that with this velocity, which greatly exceeds that with which the air can rush into a void, there must be a statical pressure of the atmosphere equal to $6\frac{1}{2}$ pounds. This will make up the difference, and allows us to conclude that the resistance arising solely from the motion communicated to the air follows very nearly the duplicate proportion of the velocity.

The next experiment, with a velocity of 1690 feet, gives a resistance equal to 157 times the weight of the bullet, and this bears a much greater proportion to the former than 1690 does to 1670; which shows, that although these experiments clearly demonstrate a prodigious augmentation of resistance, yet they are by no means susceptible of the precision which is necessary for discovering the law of this augmentation, or for a good foundation of practical rules; and it is still greatly to be wished that a more accurate mode of investigation could be discovered.

Thus we have explained, in great detail, the principles and the process of calculation for the simple case

of the motion of projectiles through the air. The learned reader will think that we have been unreasonably prolix, and that the whole might have been comprised in less room, by taking the algebraic method. We acknowledge that it might have been done even in a few lines. But we have observed, and our observation has been confirmed by persons well versed in such subjects, that in all cases where the fluxionary process introduces the fluxion of a logarithm, there is a great want of distinct ideas to accompany the hand and eye. The solution comes out by a sort of magic or legerdemain, we cannot tell either *how* or *why*. We therefore thought it our duty to furnish the reader with distinct conceptions of the things and quantities treated of. For this reason, after showing, in Sir Isaac Newton's manner, how the spaces described in the retarded motion of a projectile followed the proportion of the hyperbolic areas, we shewed the nature of another curve, where lines could be found which increase in the very same manner as the path of the projectile increases; so that a point describing the abscissa *MI* of this curve moves precisely as the projectile does. Then, discovering that this line is the same with the line of logarithms on a Gunter's scale, we shewed how the logarithm of a number really represents the path or space described by the projectile. And we were the more disposed to do this, because in the articles *LOGARITHMS* and *LOGARITHMIC Curve*, there has not been that notice taken of it which would have been proper.

Having thus, we hope, enabled the reader to conceive distinctly the quantities employed, we shall leave the geometrical method, and prosecute the rest of the subject in a more compendious manner.

60
Of the perpendicular ascents of heavy projectiles.

We are, in the next place, to consider the perpendicular ascents and descents of *heavy* projectiles, where the resistance of the air is combined with the action of gravity: and we shall begin with the descents.

Let u , as before, be the terminal velocity, and g the accelerating power of gravity: When the body moves with the velocity u , the resistance is equal to g ; and in every other velocity v , we must have $u^2 : v^2 = g : \frac{g v^2}{u^2}$, for the resistance to that velocity. In the descent the body is urged by gravity g , and opposed by the resistance $\frac{g v^2}{u^2}$: therefore the remaining accelerating force, which we shall call f , is $g - \frac{g v^2}{u^2}$, or

$$\frac{g u^2 - g v^2}{u^2}, \text{ or } \frac{g(u^2 - v^2)}{u^2} = f.$$

Now the fundamental theorem for varied motions is $f s = u \dot{v}$, and $s = \frac{v \dot{v}}{f} = \frac{u^2}{g} \times \frac{v \dot{v}}{u^2 - v^2}$, and $s = \frac{u^2}{g} \times \int \frac{v \dot{v}}{u^2 - v^2} + C$. Now the fluent of $\frac{v \dot{v}}{u^2 - v^2}$ is $-\text{hyperb. log. of } \sqrt{u^2 - v^2}$. For the fluxion of $\sqrt{u^2 - v^2}$ is $-\frac{v \dot{v}}{\sqrt{u^2 - v^2}}$, and this divided by the quantity $\sqrt{u^2 - v^2}$, of which it is the fluxion, gives precisely $\frac{v \dot{v}}{u^2 - v^2}$, which is therefore the fluxion of

its hyperbolic logarithm. Therefore $S = -\frac{u^2}{g} \times L \sqrt{u^2 - v^2} + C$. Where L means the hyperbolic logarithm of the quantity annexed to it, and λ may be used to express its common logarithm. (See article *FLUXIONS*).

The constant quantity C for completing the fluent is determined from this consideration, that the space described is 0, when the velocity is 0: therefore $C - \frac{u^2}{g} \times L \sqrt{u^2} = 0$, and $C = \frac{u^2}{g} \times L \sqrt{u^2}$, and the complete fluent $S = \frac{u^2}{g} \times L \sqrt{u^2} - L \sqrt{u^2 - v^2}$, $= \frac{u^2}{g} \times L \sqrt{\frac{u^2}{u^2 - v^2}} = \frac{u^2}{0.43429g} \times \lambda \sqrt{\frac{u^2}{u^2 - v^2}}$, or (putting M for 0.43429, the modulus or subtangent of the common logarithmic curve) $= \frac{u^2}{Mg} \times \lambda \sqrt{\frac{u^2}{u^2 - v^2}}$.

This equation establishes the relation between the space fallen through, and the velocity acquired by the fall. We obtain by it $\frac{g S}{u^2} = L \sqrt{\frac{u^2}{u^2 - v^2}}$, and $\frac{2g S}{u^2} = L \frac{u^2}{u^2 - v^2}$, or, which is still more convenient for us, $\frac{M \times 2g S}{u^2} = \lambda \frac{u^2}{u^2 - v^2}$, that is, equal to the logarithm of a certain number: therefore having found the natural number corresponding to the fraction $\frac{M \times 2g S}{u^2}$, consider it as a logarithm, and take out the number corresponding to it: call this n . Then, since n is equal to $\frac{u^2}{u^2 - v^2}$, we have $n u^2 - n v^2 = u^2$, and $n u^2 - u^2 = n v^2$, or $n v^2 = u^2 \times n - u^2$, and $v^2 = \frac{u^2 \times n - u^2}{n}$.

To expedite all the computations on this subject, it will be convenient to have multipliers ready computed for $M \times 2g$, and its half,

viz. 27,794, whose log. is	-	1.44396
and 13,897	-	1.14293

But v may be found much more expeditiously by observing that $\sqrt{\frac{u^2}{u^2 - v^2}}$ is the secant of an arch of a circle whose radius is u , and whose sine is v , or whose radius is unity and sine $= \frac{v}{u}$: therefore, considering the above fraction as a logarithmic secant, look for it in the tables, and then take the sine of the arc of which this is the secant, and multiply it by u ; the product is the velocity required.

We shall take an example of a ball whose terminal velocity is 689½ feet, and ascertain its velocity after a fall of 1848 feet. Here,

$u^2 = 475200$	and its log.	-	5.67688
$u = 689\frac{1}{2}$	-	-	2.83844
$g = 32$	-	-	1.50515
$S = 1848$	-	-	3.26670

Then

Then $\log. 27,794$	-	-	+ 1.44396
$\log. S$	-	-	+ 3.26670
$\log. u^2$	-	-	- 5.67688

Log. of 0,10809 = $\log. n$ - - - 9.03378
 0,10809 is the logarithm of 1,2826 = n , and $n-1$ =
 0,2826, and $\frac{u^2 \times n - 1}{n} = 323,6^2, = v^2$, and v =
 323,6.

In like manner, 0,054045 (which is half of 0,10809) will be found to be the logarithmic secant of 28° , whose fine 0,46947 multiplied by 689 $\frac{1}{2}$ gives 324 for the velocity.

The process of this solution suggests a very perspicuous manner of conceiving the law of descent; and it may be thus expressed:

M is to the logarithm of the secant of an arch whose fine is $\frac{v}{u}$, and radius 1, as 2a is to the height through which the body must fall in order to acquire the velocity v. Thus, to take the same example.

1. Let the height b be sought which will produce the velocity 323,62, the terminal velocity of the ball being 689,34. Here 2a, or $\frac{u^2}{g}$ is 14850, and $\frac{323,62}{689,34} = 0,46947$, which is the fine of 28° . The logarithmic secant of this arch is 0,05407. Now M or 0,43429: 0,05407 = 14850: 1848, the height wanted.

2. Required the velocity acquired by the body by falling 1848 feet. Say 14850: 1848 = 0,43429: 0,05407. Look for this number among the logarithmic secants. It will be found at 28° , of which the logarithmic fine is - - - 9.67161

Add to this the log. of u - - - 2.83844
 The sum - - - 2.51005

is the logarithm of 323,62, the velocity required.

We may observe, from these solutions, that the acquired velocity continually approaches to, but never equals, the terminal velocity. For it is always expressed by the fine of an arch of which the terminal velocity is the radius. We cannot help taking notice here of a very strange assertion of Mr Muller, late professor of mathematics and director of the royal academy at Woolwich. He maintains, in his Treatise on Gunnery, his Treatise of Fluxions, and in many of his numerous works, that a body cannot possibly move through the air with a greater velocity than this; and he makes this a fundamental principle, on which he establishes a theory of motion in a resisting medium, which he asserts with great confidence to be the only just theory; saying, that all the investigations of Bernoulli, Euler, Robins, Simpson, and others, are erroneous. We use this strong expression, because, in his criticisms on the works of those celebrated mathematicians, he lays aside good manners, and taxes them not only with ignorance, but with dishonesty; saying, for instance, that it required no small dexterity in Robins to confirm by his experiments a theory founded on false principles; and that Thomas Simpson, in attempting to conceal his obligations to him for some valuable propositions, by changing their form, had ignorantly fallen into gross errors.

Nothing can be more palpably absurd than this asser-

tion of Mr Muller. A blown bladder will have but a small terminal velocity; and when moving with this velocity, or one very near it, there can be no doubt that it will be made to move much swifter by a smart stroke. Were the assertion true, it would be impossible for a portion of air to be put into motion through the rest, for its terminal velocity is nothing. Yet this author makes this assertion a principle of argument, saying, that it is impossible that a ball can issue from the mouth of a cannon with a greater velocity than this; and that Robins and others are grossly mistaken, when they give them velocities three or four times greater, and resistances which are 10 or 20 times greater than is possible; and by thus compensating his small velocities by still smaller resistances, he confirms his theory by many experiments adduced in support of the others. No reason whatever can be given for the assertion. Newton, or perhaps Huygens, was the first who observed that there was a limit to the velocity which gravity could communicate to a body; and this limit was found by his commentators to be a term to which it was vastly convenient to refer all its other motions. It therefore became an object of attention; and Mr Muller, through inadvertency, or want of discernment, has fallen into this mistake, and with that arrogance and self-conceit which mark all his writings, has made this mistake a fundamental principle, because it led him to establish a novel set of doctrines on this subject. He was fretted at the superior knowledge and talents of Mr Simpson, his inferior in the academy, and was guilty of several mean attempts to hurt his reputation. But they were unsuccessful.

We might proceed to consider the motion of a body projected downwards. While the velocity of projection is less than the terminal velocity, the motion is determined by what we have already said: for we must compute the height necessary for acquiring this velocity in the air, and suppose the motion to have begun there. But if the velocity of projection be greater, this method fails. We pass it over (though not in the least more difficult than what has gone before), because it is of mere curiosity, and never occurs in any interesting case. We may just observe, that since the motion is swifter than the terminal velocity, the resistance must be greater than the weight, and the motion will be retarded. The very same process will give us for the space described

$$S = \frac{u^2}{g} \times L \sqrt{\frac{V^2 - u^2}{V^2 - u^2}}, \text{ V being the velocity of}$$

projection, greater than u. Now as this space evidently increases continually (because the body always falls), but does not become infinite in any finite time, the fraction $\frac{V^2 - u^2}{V^2 - u^2}$ does not become infinite; that is, v^2 does not become equal to u^2 : therefore although the velocity V is continually diminished, it never becomes so small as u. Therefore u is a limit of diminution as well as of augmentation.

We must now ascertain the relation between the time of the descent and the space described, or the velocity acquired. For this purpose we may use the other fundamental proposition of varied motions $f = \frac{v}{u}$, which, in the present case, becomes $\frac{g u^2 - v^2}{u^2} = \frac{v}{u}$; therefore $i = \frac{v}{u}$ &c.

61
 Erroneous
 assertion of
 Mr Muller.

62

Motion of
 a body pro-
 jected down-
 wards.

63

Relation
 of the time
 of descent
 and space
 described,

$$\frac{u}{g} \times \frac{v}{u^2 - v^2} = \frac{u}{g} \times \frac{uv}{u^2 - v^2}, \text{ and } t = \frac{u}{g} \times \int \frac{uv}{u^2 - v^2}.$$

Now (art. FLUXIONS) $\int \frac{uv}{u^2 - v^2} = L \sqrt{\frac{u+v}{u-v}}$. There-

fore $t = \frac{u}{g} \times L \sqrt{\frac{u+v}{u-v}} = \frac{u}{Mg} \times \lambda \sqrt{\frac{u+v}{u-v}}$. This fluent needs no constant quantity to complete it, or rather $C=0$; for t must be $=0$ when $v=0$. This will evidently be the case: for then $L \sqrt{\frac{u+v}{u-v}}$ is $L \sqrt{\frac{u}{u}} = L 1 = 0$.

But how does this quantity $\frac{u}{Mg} \times \lambda \sqrt{\frac{u+v}{u-v}}$ signify a time? Observe, that in whatever numbers, or by whatever units of space and time, u and g are expressed, $\frac{u}{g}$ expresses the number of units of time in which the velocity u is communicated or extinguished by gravity; and $L \sqrt{\frac{u+v}{u-v}}$, or $\frac{\lambda}{M} \sqrt{\frac{u+v}{u-v}}$, is always an abstract number, multiplying this time.

We may illustrate this rule by the same example. In what time will the body acquire the velocity 323,62? Here $u + v = 1012,96$, $u - v = 365,72$; therefore

$\lambda \sqrt{\frac{u+v}{u-v}} = 0,22122$, and $\frac{u}{g}$ (in feet and seconds) is 21",542. Now, for greater perspicuity, convert the equation $t = \frac{u}{Mg} \times \lambda \sqrt{\frac{u+v}{u-v}}$ into a proportion: thus $M : \lambda \sqrt{\frac{u+v}{u-v}} = \frac{u}{g} : t$, and we have 0,43429 : 0,22122 = 21",542 : 10",973, the time required.

This is by far the most distinct way of conceiving the subject; and we should always keep in mind that the numbers or symbols which we call logarithms are really parts of the line MI in the figure of the logistic curve, and that the motion of a point in this line is precisely similar to that of the body. The Marquis Poleni, in a dissertation published at Padua in 1725, has with great ingenuity constructed logarithms suited to all the cases which can occur. Herman, in his *Phoronomia*, has borrowed much of Poleni's methods, but has obscured them by an affectation of language geometrically precise, but involving the very obscure notion of abstract ratios.

It is easy to see that $\sqrt{\frac{u+v}{u-v}}$ is the cotangent of the $\frac{1}{2}$ complement of an arch, whose radius is 1, and whose sine is $\frac{v}{u}$. For let KC (fig. 6.) be $=u$, and BE $=v$; then KD $=u+v$, and DA $=u-v$. Join KB and BA, and draw CG parallel to KB. Now GA is the tangent of $\frac{1}{2} B\hat{A}$, $=\frac{1}{2}$ complement of HB. Then, by similarity of triangles, GA : AC = AB : BK, = $\sqrt{AD} : \sqrt{DK} = \sqrt{u-v} : \sqrt{u+v}$ and $\frac{AC}{GA} (= \cotan. \frac{1}{2} B\hat{A}) = \sqrt{\frac{u+v}{u-v}}$; therefore look for $\frac{v}{u}$ among the natural sines, or for log. $\frac{v}{u}$ among the logarithmic sines,

and take the logarithmic cotangent of the half complement of the corresponding arch. This, considered as a common number, will be the second term of our proportion. This is a shorter process than the former.

By reverting this proportion we get the velocity corresponding to a given time.

To compare this descent of 1848 feet in the air with the fall of the body in *vacuo* during the same time, say $21",542 : 10",973 = 1848 : 1926,6$, which makes a difference of 79 feet. 64
body in
air compared with
that of one
in *vacuo*.

Cor. 1. The time in which the body acquires the velocity u by falling through the air, is to the time of acquiring the same velocity by falling in *vacuo*, as u

$L \sqrt{\frac{u+v}{u-v}}$ to v : for it would acquire this velocity in *vacuo* during the time $\frac{v}{g}$, and it acquires it in the air in the time $\frac{u}{g} L \sqrt{\frac{u+v}{u-v}}$.

2. The velocity which the body acquires by falling through the air in the time $\frac{u}{g} L \sqrt{\frac{u+v}{u-v}}$, is to the velocity which it would acquire in *vacuo* during the same time, as v to $u L \sqrt{\frac{u+v}{u-v}}$. For the velocity which it would acquire in *vacuo* during the time $\frac{u}{g} L \sqrt{\frac{u+v}{u-v}}$ must be $u L \sqrt{\frac{u+v}{u-v}}$ (because in any time $\frac{w}{g}$ the velocity w is acquired).

In the next place, let a body, whose terminal velocity is u , be projected perpendicularly upwards, with any velocity V . It is required to determine the height to which it ascends, so as to have any remaining velocity v , and the time of its ascent; as also the height and time in which its whole motion will be extinguished. 65
Time of
the ascent
of a body
projected
perpendi-
cularly.

We have now $\frac{g(u^2 + v^2)}{u^2}$ for the expression of f ; for both gravity and resistance act now in the same direction, and retard the motion of the ascending body: therefore $\frac{g(u^2 + v^2)}{u^2} : = -v \dot{v}$, and $s = -\frac{u^2}{g} \times \frac{v \dot{v}}{u^2 + v^2}$, and $s = -\frac{u^2}{g} \times \int \frac{v \dot{v}}{u^2 + v^2} + C = -\frac{u^2}{g} \times L \sqrt{\frac{u^2 + v^2}{u^2 + V^2}} + C$ (see art. FLUXIONS). This must be $=0$ at the beginning of the motion, that is, when $v=V$, that is, $-\frac{u^2}{g} \times L \sqrt{\frac{u^2 + V^2}{u^2 + V^2}} + C = 0$, or $C = \frac{u^2}{g} \times L \sqrt{\frac{u^2 + V^2}{u^2 + V^2}}$, and the complete fluent will be $s = \frac{u^2}{g} \times (L \sqrt{\frac{u^2 + V^2}{u^2 + v^2}} - L \sqrt{\frac{u^2 + V^2}{u^2 + V^2}}) = \frac{u^2}{g} \times \lambda \sqrt{\frac{u^2 + V^2}{u^2 + v^2}}$.

Let h be the greatest height to which the body will rise. Then $s = h$ when $v = 0$; and $h = \frac{u^2}{g} \times L \sqrt{\frac{u^2 + V^2}{u^2}}$. We have $\lambda \sqrt{\frac{u^2 + V^2}{u^2 + v^2}} = \frac{u^2}{Mg} \times \lambda \sqrt{\frac{u^2 + V^2}{u^2 + v^2}}$. Therefore $\lambda \sqrt{\frac{u^2 + V^2}{u^2 + v^2}} = \frac{Mg}{u^2}$; therefore $\lambda \left(\frac{u^2 + V^2}{u^2 + v^2} \right) = \frac{2Mgs}{u^2}$.
Therefore

Therefore let n be the number whose common logarithm is $\frac{2Mg}{u^2}$; we shall have $n = \frac{u^2 + V^2}{u^2 + v^2}$, and $v^2 = \frac{u^2 + V^2}{n} - u^2$; and thus we obtain the relation of s and v , as in the case of descents: but we obtain it still easier by observing that $\sqrt{u^2 + V^2}$ is the secant of an arch whose radius is u , and whose tangent is V , and that $\sqrt{u^2 + v^2}$ is the secant of another arch of the same circle, whose tangent is v .

Let the same ball be projected upwards with the velocity 411.05 feet per second. Required the whole height to which it will rise?

Here $\frac{V}{u}$ will be found the tangent of $30.48\frac{1}{2}$, the logarithmic secant of which is 0.06606. This, multiplied by $\frac{u^2}{Mg}$, gives 2259 feet for the height. It would have risen 2640 feet in a void.

Suppose this body to fall down again. We can compare the velocity of projection with the velocity with which it again reaches the ground. The ascent and descent are equal: therefore $\sqrt{\frac{u^2 + V^2}{u^2}}$, which multiplies the constant factor in the ascent, is equal to $\sqrt{\frac{u^2}{u^2 - v^2}}$, the multiplier in the descent. The first is the secant of an arch whose tangent is V ; the other is the secant of an arch whose sine is v . These secants are equal, or the arches are the same; therefore the velocity of projection is to the final returning velocity as the tangent to the sine, or as the radius to the cosine of the arch. Thus suppose the body projected with the terminal velocity, or $V = u$; then $v = \frac{u}{\sqrt{2}}$. If $V = 689$, $v = 487$.

We must in the last place ascertain the relation of the space and the time.

Here $\frac{g(u^2 + v^2)}{u^2} \dot{t} = -\dot{v}$, and $\dot{t} = -\frac{u^2}{g} \times \frac{\dot{v}}{u^2 + v^2} = -\frac{u}{g} \times \frac{u \dot{v}}{u^2 + v^2}$; and $t = -\frac{u}{g} \times \int \frac{u \dot{v}}{u^2 + v^2} + C$. Now (art. FLUXIONS) $\int \frac{u \dot{v}}{u^2 + v^2}$ is an arch whose tangent $= \frac{v}{u}$ and radius 1; therefore $t = -\frac{u}{g} \times \text{arc. tan. } \frac{v}{u} + C$. This must be $= 0$ when $v = V$, or $C = \frac{u}{g} \times \text{arc. tan. } \frac{V}{u}$. $\frac{V}{u} = 0$, and $C = \frac{u}{g} \times \text{arc. tan. } \frac{V}{u}$, and the complete fluent is $t = \frac{u}{g} \times \left(\text{arc. tan. } \frac{V}{u} - \text{arc. tan. } \frac{v}{u} \right)$. The quantities within the brackets express a portion of the arch of a circle whose radius is unity; and are therefore abstract numbers, multiplying $\frac{u}{g}$, which we have shown to be the number of units of time in which a heavy body falls in *vacuo* from the height a , or in which it acquires the velocity u .

We learn from this expression of the time, that however great the velocity of projection, and the height

to which this body will rise, may be the time of its ascent is limited. It never can exceed the time of falling from the height a in *vacuo* in a greater proportion than that of a quadrantal arch to the radius, nearly the proportion of 8 to 5. A 24 pound iron ball cannot continue rising above 14 seconds, even if the resistance to quick motions did not increase faster than the square of the velocity. It probably will attain its greatest height in less than 12 seconds, let its velocity be ever so great.

In the preceding example of the whole ascent, $v = 0$, and the time $t = \frac{u}{g} \times \text{arc. tan. } \frac{V}{u}$, or $\frac{u}{g} \text{ arc. } 30^\circ.48'$. Now $30^\circ.48' = 1848'$, and the radius 1 contains 3438; therefore the arch $= \frac{1848}{3438}$, $= 0.5376$; and $\frac{u}{g} = 21''.54$. Therefore $t = 21''.54 \times 0.5376 = 11''.58$, or nearly $11\frac{1}{2}$ seconds. The body would have risen to the same height in a void in $10\frac{1}{2}$ seconds.

Cor. 1. The time in which a body, projected in the air with any velocity V , will attain its greatest height, is to that in which it would attain its greatest height in *vacuo*, as the arch whose tangent expresses the velocity in air and is to the tangent; for the time of the ascent in the air is $\frac{u}{g} \times \text{arch}$; the time of the ascent in *vacuo* is $\frac{V}{g}$. Now $\frac{V}{u} = \tan.$ and $V = u \times \tan.$ and $\frac{V}{g} = \frac{u}{g} \times \tan.$

It is evident, by inspecting fig. 6. that the arch AI is to the tangent AG as the sector ICA to the triangle GCA; therefore the time of attaining the greatest height in the air is to that of attaining the greatest height in *vacuo* (the velocities of projection being the same), as the circular sector to the corresponding triangle.

If therefore a body be projected upwards with the terminal velocity, the time of its ascent will be to the time of acquiring this velocity in *vacuo* as the area of a circle to the area of the circumscribed square.

2. The height H to which a body will rise in a void, is to the height b to which it would rise through the air when projected with the same velocity V as $M \cdot V^2$ to $u^2 \times \lambda \frac{u^2 + V^2}{u^2}$: for the height to which it will rise in

vacuo is $\frac{V^2}{2g}$, and the height to which it rises in the air is $\frac{u^2}{Mg} \lambda \sqrt{\frac{u^2 + V^2}{u^2}}$; therefore $H : b = \frac{V^2}{2g} : \frac{u^2}{Mg} \lambda \sqrt{\frac{u^2 + V^2}{u^2}}$, $= V^2 : \frac{u^2}{M} \times 2 \lambda \sqrt{\frac{u^2 + V^2}{u^2}}$, $= V^2 : \frac{u^2}{M} \times \lambda \frac{u^2 + V^2}{u^2}$, $= M \cdot V^2 : u^2 \times \lambda \frac{u^2 + V^2}{u^2}$.

Therefore if the body be projected with its terminal velocity, so that $V = u$, the height to which it will rise in the air is $\frac{30103}{43429}$ of the height to which it will rise in *vacuo*, or $\frac{5}{7}$ in round numbers.

We have been thus particular in treating of the perpendicular ascents and descents of heavy bodies through the air, in order that the reader may conceive distinctly the

66
Velocity of projection compared with that with which it reaches the ground.

68
This time compared in bodies projected in air and in *vacuo*.

Plate
ccccxvii.

67
Time of ascent limited.

69
Necessity
of further
experi-
ments.

70
Of ob-
lique pro-
jection.

71
This pro-
blem not
solved by
Newton.

the quantities which he is thus combining in his algebraic operations, and may see their connection in nature with each other. We shall also find that, in the present state of our mathematical knowledge, this simple state of the case contains almost all that we can determine with any confidence. On this account, it were to be wished that the professional gentlemen would make many experiments on these motions. There is no way that promises so much for assisting us in forming accurate notions of the air's resistance. Mr Robins's method with the pendulum is impracticable with great shot; and the experiments which have been generally resorted to for this purpose, viz. the ranges of shot and shells on a horizontal plane, are so complicated in themselves, that the utmost mathematical skill is necessary for making any inferences from them; and they are subject to such irregularities, that they may be brought to support almost any theory whatever on this subject. But the perpendicular flights are affected by nothing but the initial velocity and the resistance of the air; and a considerable deviation from their intended direction does not cause any sensible error in the consequences which we may draw from them for our purpose.

But we must now proceed to the general problem, to determine the motion of a body projected in any direction, and with any velocity. Our readers will believe beforehand that this must be a difficult subject, when they see the simplest cases of rectilinear motion abundantly abstruse: it is indeed so difficult, that Sir Isaac Newton has not given a solution of it, and has thought himself well employed in making several approximations, in which the fertility of his genius appears in great lustre. In the tenth and subsequent propositions of the second book of the *Principia*, he shows what state of density in the air will comport with the motion of a body in any curve whatever: and then, by applying this discovery to several curves which have some similarity to the path of a projectile, he finds one which is not very different from what we may suppose to obtain in our atmosphere. But even this approximation was involved in such intricate calculations, that it seemed impossible to make any use of it. In the second edition of the *Principia*, published in 1713, Newton corrects some mistakes which he had committed in the first, and carries his approximations much farther, but still does not attempt a direct investigation of the path which a body will describe in our atmosphere. This is somewhat surprising. In prop. 14. &c. he shows how a body, actuated by a centripetal force, in a medium of a density varying according to certain laws, will describe an eccentric spiral, of which he assigns the properties, and the law of description. Had he supposed the density constant, and the difference between the greatest and least distances from the centre of centripetal force exceedingly small in comparison with the distances themselves, his spiral would have coincided with the path of a projectile in the air of uniform density, and the steps of his investigation would have led him immediately to the complete solution of the problem. For this is the real state of the case. A heavy body is not acted on by equal and parallel gravity, but by a gravity inversely proportional to the square of the distance from the centre of the earth, and in lines tending to that centre nearly; and it was with the view of simplifying the

investigation, that mathematicians have adopted the other hypothesis.

Soon after the publication of this second edition of the *Principia*, the dispute about the invention of the fluxionary calculus became very violent, and the great promoters of that calculus upon the continent were in the habit of proposing difficult problems to exercise the talents of the mathematician. Challenges of this kind frequently passed between the British and foreigners. Dr Keill of Oxford had keenly espoused the claim of Sir Isaac Newton to this invention, and had engaged in a very acrimonious altercation with the celebrated John Bernoulli of Basle. Bernoulli had published in the *Acta Eruditorum Lipsiæ* an investigation of the law of forces, by which a body moving in a resisting medium might describe any proposed curve, reducing the whole to the simplest geometry. This is perhaps the most elegant specimen which he has given of his great talents. Dr Keill proposed to him the particular problem of the trajectory and motion of a body moving through the air, as one of the most difficult. Bernoulli very soon solved the problem in a way much more general than it had been proposed, viz. without any limitation either of the law of resistance, the law of the centripetal force, or the law of density, provided only that they were regular, and capable of being expressed algebraically. Dr Brooke Taylor, the celebrated author of the *Method of Increments*, solved it at the same time, in the limited form in which it was proposed. Other authors since that time have given other solutions. But they are all (as indeed they must be) the same in substance with Bernoulli's. Indeed they are all (Bernoulli's not excepted) the same with Newton's first approximations, modified by the steps introduced into the investigation of the spiral motions mentioned above; and we still think it most strange that Sir Isaac did not perceive that the variation of curvature, which he introduced in that investigation, made the whole difference between his approximations and the complete solution. This we shall point out as we go along. And we now proceed to the problem itself, of which we shall give Bernoulli's solution, restricted to the case of uniform density and a resistance proportional to the square of the velocity. This solution is more simple and perspicuous than any that has since appeared.

PROBLEM. To determine the trajectory, and all the circumstances of the motion, of a body projected thro' the air from A (fig. 7.) in the direction AB, and resisted in the duplicate ratio of the velocity.

Let the arch AM be put $=z$, the time of describing it t , the abscissa AP $=x$, the ordinate PM $=y$. Let the velocity in the point M $=v$, and let MN, $=z$, be described in the moment t ; let r be the resistance of the air, g the force of gravity, measured by the velocity which it will generate in a second; and let a be the height through which a heavy body must fall *in vacuo* to acquire the velocity which would render the resistance of the air equal to its gravity: so that we have

$r = \frac{v^2}{2a}$; because, for any velocity v , and producing

height b , we have $g = \frac{u^2}{2b}$

Let Mm touch the curve in M; draw the ordinate pNm,

Plate
cccxcvii.

pN , and draw Mo , Nn perpendicular to Np and Mm . Then we have $MN = z$, and $Mo = x$, also mo is ultimately $= y$ and Mm is ultimately $= MN$ or z . Lastly, let us suppose x to be a constant quantity, the elementary ordinates being supposed equidistant.

74
Action of
gravity in
a given
time.

The action of gravity during the time t may be measured by mN , which is half the space which it would cause the body to describe uniformly in the time t with the velocity which it generates in that time. Let this be resolved into nN , by which it deflects the body into a curvilinear path, and mn , by which it retards the ascent and accelerates the descent of the body along the tangent. The resistance of the air acts solely in retarding the motion, both in ascending and descending, and has no deflective tendency. The whole action of gravity then is to its accelerating or retarding tendency as mN to mn , or (by similarity of triangles) as mM to mo . Or $z : y = g : \frac{g y}{z}$, and the whole retardation in

the ascent will be $r + \frac{g y}{z}$. The same fluxionary symbol will express the retardation during the descent, because in the descent the ordinates decrease, and y is a negative quantity.

The diminution of velocity is $-\dot{v}$. This is proportional to the retarding force and to the time of its action jointly, and therefore $-\dot{v} = r + \frac{g y}{z} \times t$; but the time t is as the space z divided by the velocity v ; therefore $-\dot{v} = r + \frac{g y}{z} \times \frac{z}{v} = -\frac{r z + g y}{v}$, and $-\dot{v} = -\frac{r z - g y}{v} = \frac{v^2 z}{2 a} - g y$. Because mN is the deflection by gravity, it is as the force g and the square of the time t jointly (the momentary action being held as uniform). We have therefore mN , or $-\ddot{y} = g t^2$. (Observe that mN is in fact only the half of $-\ddot{y}$; but g being twice the fall of a heavy body in a second, we have $-\ddot{y}$ strictly equal to $g t^2$). But $t^2 = \frac{z^2}{v^2}$; therefore $-\ddot{y} = \frac{g z^2}{v^2}$,

and $v^2 = \frac{g z^2}{-\ddot{y}}$, and $-v^2 \ddot{y} = g z^2$. The fluxion of

this equation is $-v^2 \ddot{y} - 2 v \dot{y} \dot{v} = 2 g z \dot{z}$; but, because $z : y = mM : mo = mN : mn = \ddot{y} : z$, we have $\dot{z} \dot{z} = y \ddot{y}$. Therefore $2 g y \ddot{y} = 2 g z \dot{z}$, $= -v^2 \dot{y} - 2 v \dot{y} \dot{v}$, and $-2 v \dot{y} \dot{v} = v^2 \dot{y}$, $-2 g y \ddot{y}$, and $-v \dot{v} = \frac{v^2 \dot{y}}{2 y} - g \ddot{y}$. But we have already $-\dot{v} = -\frac{r z + g y}{v}$, therefore $\frac{v^2 \dot{y}}{2 a} - g \ddot{y}$; therefore $\frac{v^2 \dot{y}}{y} = \frac{v^2 \dot{z}}{a}$, and finally $\frac{\dot{y}}{y} = \frac{\dot{z}}{a}$.

$\frac{\dot{z}}{a}$, or $a \ddot{y} = \dot{z} \ddot{y}$, for the fluxionary equation of the curve.

If we put this into the form of a proportion, we have $a : z = \ddot{y} : y$. Now this evidently establishes a relation between the length of the curve and its variation of the curve and its evolution, which are the very circumstances introduced by Newton into his investigation of the spiral motions. And

the equation $\frac{\dot{z}}{a} = \frac{\ddot{y}}{y}$ is evidently an equation connect-

ed with the logarithmic curve and the logarithmic spiral. But we must endeavour to reduce it to a lower order of fluxions, before we can establish a relation between z , x , and y .

Let p express the ratio of y to x , that is, let p be $= \frac{y}{x}$, or $p x = y$. It is evident that this expresses the inclination of the tangent at M to the horizon, and that p is the tangent of this inclination, radius being unity. Or it may be considered merely as a number, multiplying x , so as to make it $= y$. We now have $y^2 = p^2 x^2$, and since $z^2 = x^2 + y^2$, we have $z^2 = x^2 + p^2 x^2 = 1 + p^2 \times x^2$ and $z = x \sqrt{1 + p^2}$.

Moreover, because we have supposed the abscissa x to increase uniformly, and therefore \dot{x} to be constant, we have $\dot{y} = \dot{x} p$, and $\ddot{y} = \dot{x} \dot{p}$. Now let q express the ratio of \dot{p} to \dot{x} , that is, make $\frac{\dot{p}}{\dot{x}} = q$, or $q \dot{x} = \dot{p}$.

This gives us $\dot{x} q = \dot{p}$, and $\dot{x}^2 q = \dot{x} \dot{p} = \ddot{y}$.

By these substitutions our former equation $a \ddot{y} = \dot{z} \ddot{y}$ changes to $a \dot{x}^2 q = \dot{x} \sqrt{1 + p^2} \dot{x} \dot{p}$, or $a q = \dot{p} \sqrt{1 + p^2}$, and, taking the fluent on both sides, we have $a q = \int \dot{p} \sqrt{1 + p^2} + C$, C being the constant quantity required for completing the fluent according to the limiting conditions of the case. Now $\dot{x} = \frac{p}{q}$, and $\frac{1}{q} =$

$\int \frac{a}{p \sqrt{1 + p^2}} + C$. Therefore $\dot{x} = \int \frac{a p}{p \sqrt{1 + p^2}} + C$

Also, since $\dot{y} = p \dot{x} = \frac{p \dot{p}}{q}$, we have $y =$

$\int \frac{a p \dot{p}}{p \sqrt{1 + p^2}} + C$

Also $\dot{z} = \dot{x} \sqrt{1 + p^2} = \frac{a p \sqrt{1 + p^2}}{\int \frac{a p \dot{p}}{p \sqrt{1 + p^2}} + C}$

The values of \dot{x} , \dot{y} , \dot{z} , give us

$x = \int \frac{a p}{p \sqrt{1 + p^2}} + C = a \int \frac{p}{p \sqrt{1 + p^2}} + C$

$$y = \int \frac{ap \dot{p}}{f, \dot{p} \sqrt{1+p^2} + C} = a \int \frac{\dot{p}}{f, \dot{p} \sqrt{1+p^2} + C}$$

$$z = \int \frac{a \sqrt{1+p^2} \dot{p}}{f, \dot{p} \sqrt{1+p^2} + C} = a \int \frac{\dot{p} \sqrt{1+p^2}}{f, \dot{p} \sqrt{1+p^2} + C}$$

The process therefore of describing the trajectory is, *i. fl.* To find q in terms of p by the area of the curve whose abscissa is p and the ordinate is $\sqrt{1+p^2}$.

2d, We get x by the area of another curve whose abscissa is p , and the ordinate is $\frac{1}{q}$.

3d, We get y by the area of a third curve whose abscissa is p , and the ordinate is $\frac{p}{q}$.

The problem of the trajectory is therefore completely solved, because we have determined the ordinate, abscissa, and arch of the curve for any given position of its tangent. It now only remains to compute the magnitudes of these ordinates and abscissæ, or to draw them by a geometrical construction. But in this consists the difficulty. The areas of these curves, which express the lengths of x and y , can neither be computed nor exhibited geometrically, by any accurate method yet discovered, and we must content ourselves with approximations. These render the description of the trajectory exceedingly difficult and tedious, so that little advantage has as yet been derived from the knowledge we have got of its properties. It will however greatly assist our conception of the subject to proceed some length in this construction; for it must be acknowledged that very few distinct notions accompany a mere algebraic operation, especially if in any degree complicated, which we confess is the case in the present question.

Let $BmNR$ (fig. 8.) be an equilateral hyperbola, of which B is the vertex, BA the semitransverse axis, which we shall assume for the unity of length. Let AV be the semiconjugate axis $= BA$, $=$ unity, and AS the asymptote, bisecting the right angle BAV . Let PN , pn be two ordinates to the conjugate axis, exceedingly near to each other. Join BP , AN , and draw $B'N$ perpendicular to the asymptote, and BC parallel to AP . It is well known that BP is equal to NP . Therefore $PN^2 = BA^2 + AP^2$. Now since $BA = 1$, if we make $AP = p$ of our formulæ, $PN = \sqrt{1+p^2}$, and Pp is $= \dot{p}$, and the area $BAPNB = \int \frac{\dot{p} \sqrt{1+p^2}}{f, \dot{p} \sqrt{1+p^2} + C}$. That is to

say, the number $\int \frac{\dot{p} \sqrt{1+p^2}}{f, \dot{p} \sqrt{1+p^2} + C}$ (for it is a number) has the same proportion to unity of number that the area $BAPNB$ has to $BCVA$, the unit of surface. This area consists of two parts, the triangle APN , and the hyperbolic sector ABN . $APN = \frac{1}{2} AP \times PN = \frac{1}{2} p \sqrt{1+p^2}$, and the hyperbolic sector $ABN = BN \cdot \beta$, which is equivalent to the hyperbolic logarithm of the number represented by A , when AS is unity. Therefore it is equal to $\frac{1}{2}$ the logarithm of $p + \sqrt{1+p^2}$. Hence we see by the bye that $\int \frac{\dot{p} \sqrt{1+p^2}}{f, \dot{p} \sqrt{1+p^2} + C} = \frac{1}{2} p \sqrt{1+p^2} + \frac{1}{2}$ hyperbolic logarithm $p + \sqrt{1+p^2}$.

Now let AMD be another curve, such that its ordinates Vm , PD , &c. may be proportional to the areas $ABmV$, $ABNP$, and may have the same proportion to AB , the unity of length, which these areas have to $ABCV$, the unity of surface. Then $VM : VC =$

$Vm BA : VCBA$ and $PD : Pp = PNBA : VCBA$, &c. These ordinates will now represent $\int \frac{\dot{p} \sqrt{1+p^2}}{f, \dot{p} \sqrt{1+p^2} + C}$

with reference to a linear unit, as the areas to the hyperbola represented it in reference to a superficial unit.

Again, in every ordinate make $PD : Pp = Pp : PO$, and thus we obtain a reciprocal to PD or to $\int \frac{\dot{p} \sqrt{1+p^2}}{f, \dot{p} \sqrt{1+p^2} + C}$, or equivalent to $\int \frac{1}{p \sqrt{1+p^2}}$. This

will evidently be $\frac{x}{ap}$, and $PO \circ p$ will be $\frac{x}{a}$, and the area

contained between the lines AF , AW , and the curve $GEOH$, and cut off by the ordinate PO , will represent

$\frac{x}{a}$.

Lastly, make $PO : PQ = AV : AP = 1 : p$; and

then $PQ \circ p$ will represent $\frac{y}{a}$, and the area $ALEQP$

will represent $\frac{y}{a}$.

But we must here observe, that the fluents expressed by these different areas require what is called the *correction* to accommodate them to the circumstances of the case. It is not indifferent from what ordinate we begin to reckon the areas. This depends on the initial direction of the projectile, and that point of the abscissa AP must be taken for the commencement of all the areas which gives a value of p suited to the initial direction. Thus, if the projection has been made from A (fig. 7.) at an elevation of 45° , the ratio of the fluxions x and y is that of equality; and therefore the point E of fig. 8. where the two curves intersect and have a common ordinate, evidently corresponds to this condition. The ordinate EV passes through V , so that AV or $p = AB = 1$, $=$ tangent 45° , as the case requires. The values of x and of y corresponding to any other point of the trajectory, such as that which has AP for the tangent of the angle which it makes with the horizon, are now to be had by computing the areas $VEOP$, $VEQP$.

Another curve might have been added, of which the ordinates would exhibit the fluxions of the arch of the

trajectory $z = \int \frac{a \dot{p} \sqrt{1+p^2}}{f, \dot{p} \sqrt{1+p^2} + C}$ and of which the area

would exhibit the arch itself. And this would have been very easy, for it is $z = a \int \frac{\dot{p} \sqrt{1+p^2}}{f, \dot{p} \sqrt{1+p^2} + C}$,

which is evidently the fluxion of the hyperbolic logarithm of $f, \dot{p} \sqrt{1+p^2}$. But it is needless, since $z =$

$x \sqrt{1+p^2}$, and we have already got x . It is only increasing PO in the ratio of BA to BP .

And thus we have brought the investigation of this problem a considerable length, having ascertained the *form* of the trajectory. This is surely done when the ratio of the arch, abscissæ, and ordinate, and the position of its tangent, is determined in every point. But it is still very far from a solution, and much remains to be done before we can make any practical application of it. The only general consequence that we can deduce from the premises

76
To compute the magnitude of the ordinate and abscissa.

Plate
ccccxviii.

Plate
ccccxvii.
Plate
ccccxviii.

77
Consequently of the form of the trajectory.

PROJECTILES.

Fig. 3. Plate CCCCXVII.

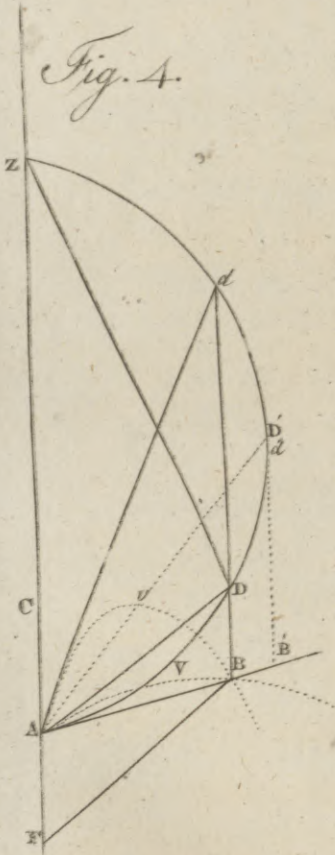
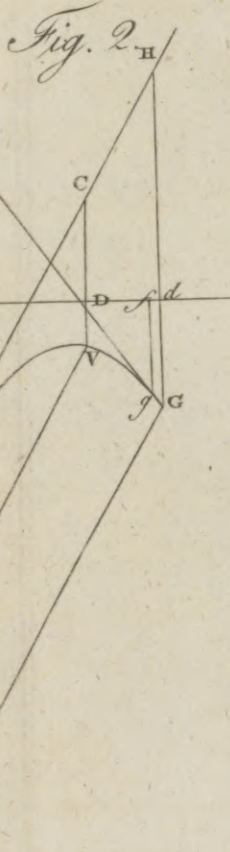
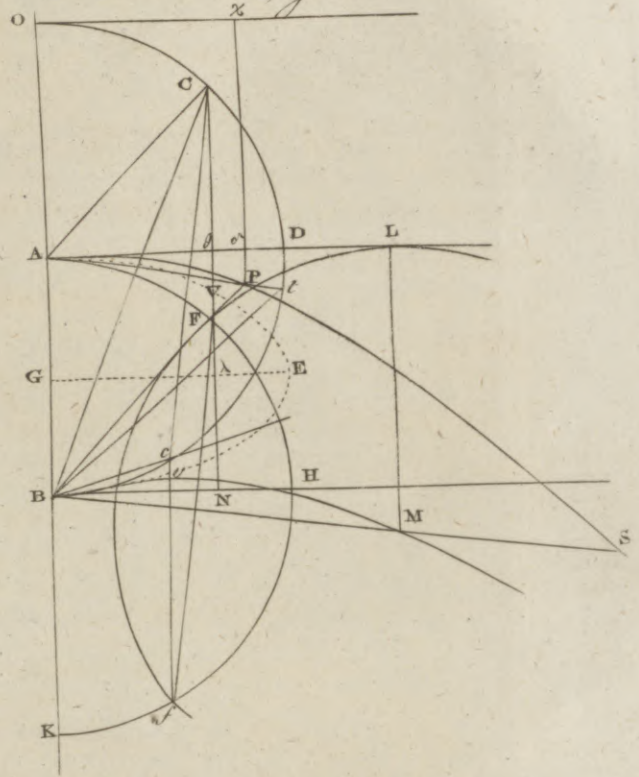
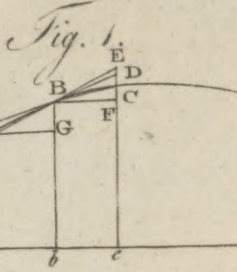
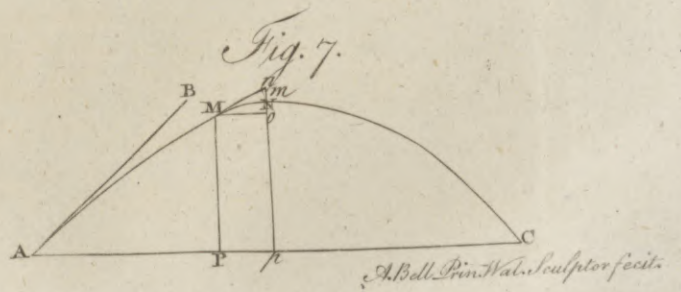
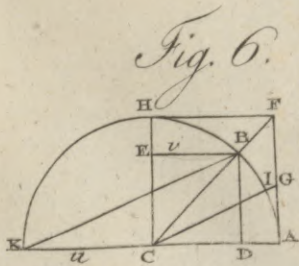
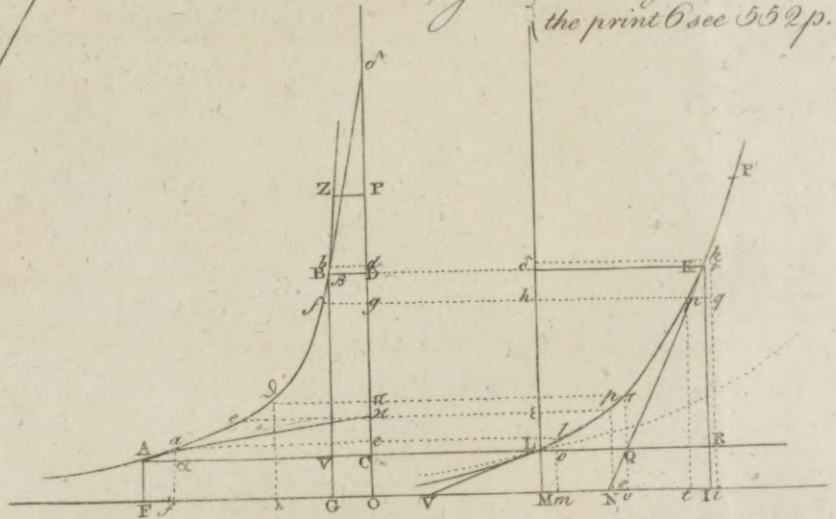


Fig. 5. called by mistake in the print 6 sec 552 p.



A. Bell Pin. Wat. Sculptor fecit.

PROCTOR

PROCTOR

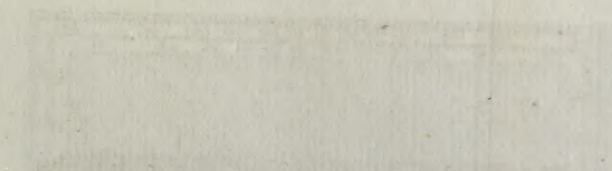
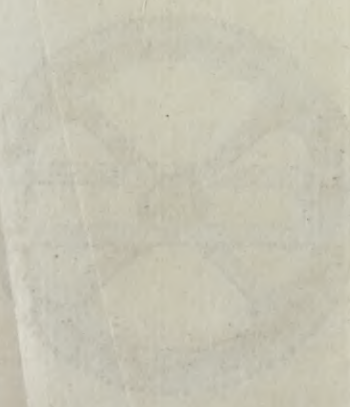


Fig. 8.

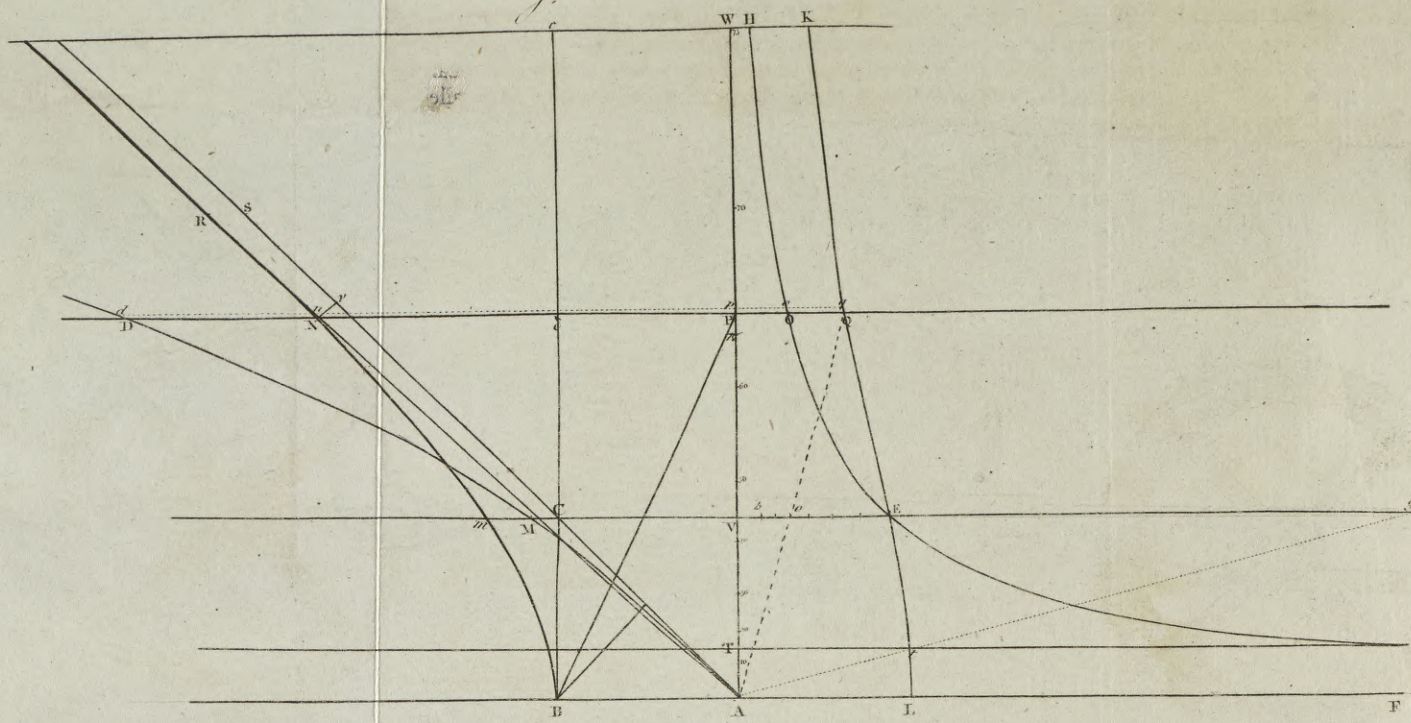


Fig. 9.

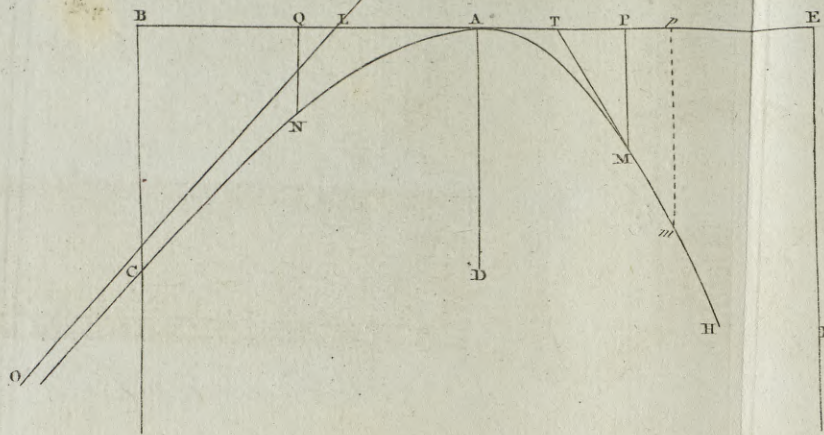


Fig. 10.

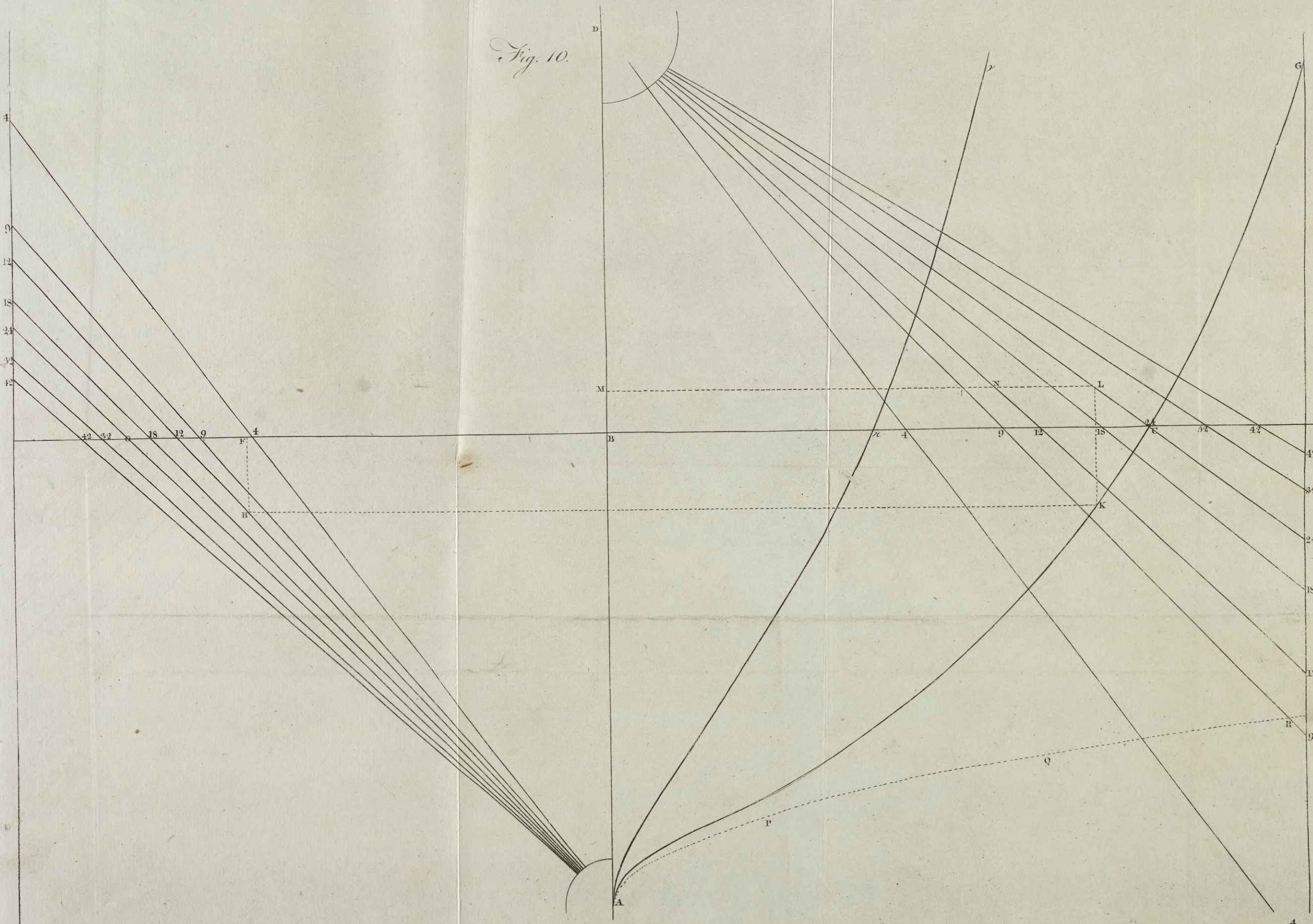


Fig. 1.

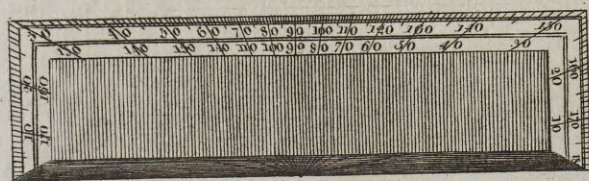
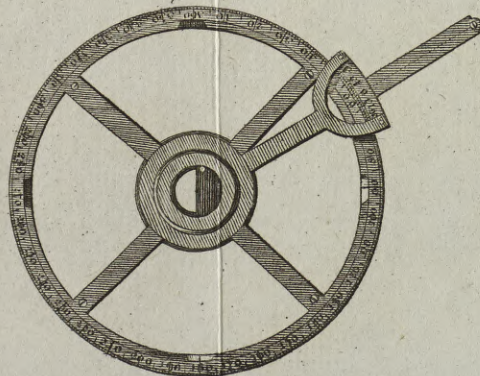


Fig. 2.



PROTRACTOR.

Fig. 3.

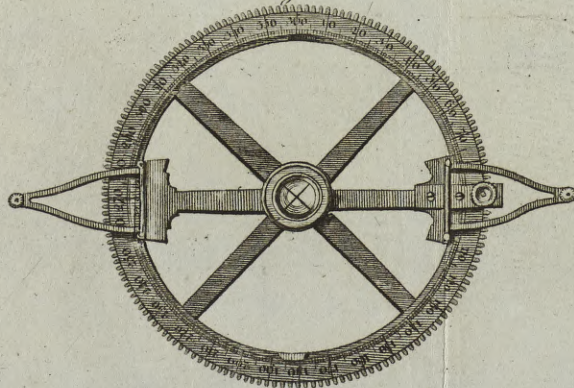


Fig. 4.

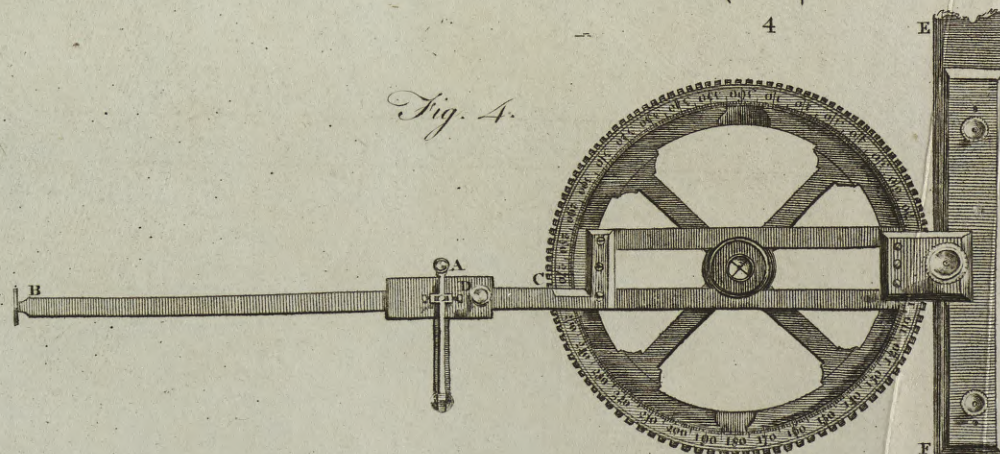
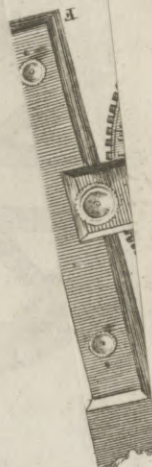
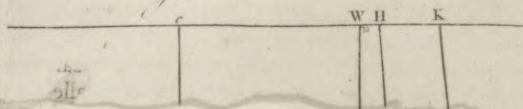


Fig. 8.



ses is, that in every case where the resistance in any point bears the same proportion to the force of gravity, the trajectory will be similar. Therefore two balls, of the same density, projected in the same direction, will describe similar trajectories if the velocities are in the subduplicate ratio of the diameters. This we shall find to be of considerable practical importance. But let us now proceed to determine the velocity in the different points of the trajectory, and the time of describing its several portions.

Recollect, therefore, that $v^2 = \frac{-gz^2}{y}$ and that \dot{z}^2

$$= \dot{x}^2 + \dot{p}^2 \text{ and } \dot{y} = \dot{x}\dot{p}. \text{ This gives } v^2 = \frac{-g\dot{x} + \dot{p}^2}{\dot{p}}.$$

$$\text{But } \dot{p} = q\dot{x}. \text{ Therefore } v^2 = \frac{-g\dot{x} + \dot{p}^2}{q} = \frac{-a\dot{x} + \dot{p}^2}{q}, \text{ and } v = \sqrt{\frac{-g\dot{x} + \dot{p}^2}{q}} = \frac{\sqrt{a\sqrt{-g}\sqrt{1+\dot{p}^2}}}{\sqrt{f\dot{p}\sqrt{1+\dot{p}^2} + C}}.$$

$$\text{Also } i \text{ was found } = \frac{\dot{z}}{v} = \frac{\dot{x}\sqrt{1+\dot{p}^2}}{v} =$$

$$\frac{\dot{p}\sqrt{1+\dot{p}^2}}{qv}. \text{ If we now substitute for } v \text{ its value}$$

$$\text{just found, we obtain } i = \frac{\dot{p}}{\sqrt{-gq}}, \text{ and } t = \int \frac{\dot{p}}{\sqrt{-gq}}$$

$$= \int \frac{\dot{p}\sqrt{a}}{\sqrt{-g\dot{p}\sqrt{1+\dot{p}^2} + C}} = \frac{\sqrt{a}}{\sqrt{-g}} \times$$

$$\int \frac{\dot{p}}{\sqrt{f\dot{p}\sqrt{1+\dot{p}^2} + C}}.$$

79
Difficulty of accommodating the formulae to particular cases.

The greatest difficulty still remains, viz. the accommodating these formulae, which appear abundantly simple, to the particular cases. It would appear at first sight, that all trajectories are similar; since the ratio of the fluxions of the ordinate and abscissa corresponding to any particular angle of inclination to the horizon seems the same in them all: but a due attention to what has been hitherto said on the subject will show us that we have as yet only been able to ascertain the velocity in the point of the trajectory, which has a certain inclination to the horizon, indicated by the quantity p , and the time (reckoned from some assigned beginning) when the projectile is in that point.

To obtain absolute measures of these quantities, the term of commencement must be fixed upon. This will be expressed by the constant quantity C , which is assumed for completing the fluent of $\dot{p}\sqrt{1+\dot{p}^2}$, which is the basis of the whole construction. We there found $q =$

$$\frac{\int \dot{p}\sqrt{1+\dot{p}^2}}{a}. \text{ This fluent is in general } q =$$

$$\frac{C + \int \dot{p}\sqrt{1+\dot{p}^2}}{a}, \text{ and the constant quantity } C \text{ is to}$$

be accommodated to some circumstances of the case. Different authors have selected different circumstances. Euler, in his Commentary on Robins, and in a dissertation in the Memoirs of the Academy of Berlin published in 1753, takes the vertex of the curve for the beginning

80
Euler's method the simplest.

of his abscissa and ordinate. This is the simplest method of any, for C must then be so chosen that the whole fluent may vanish when $p=0$, which is the case in the vertex of the curve, where the tangent is parallel to the horizon. We shall adopt this method.

Therefore, let AP (fig. 9.) $= x$, $PM = y$, $AM = z$. Put the quantity C which is introduced into the fluent

Plate CCCCXVIII.

equal to $\frac{n}{a}$. It is plain that n must be a number; for

it must be homologous with $\dot{p}\sqrt{1+\dot{p}^2}$, which is a number. For brevity's sake let us express the fluent of $\dot{p}\sqrt{1+\dot{p}^2}$ by the single letter P ; and thus we shall

$$\text{have } x = a \times \int \frac{\dot{p}}{n+P}, y = a \times \int \frac{\dot{p}\dot{p}}{n+P}, z = a \times$$

$$\int \frac{\dot{p}\sqrt{1+\dot{p}^2}}{n+P}. \text{ And } v^2 = \frac{-ag(1+\dot{p}^2)}{n+P}. \text{ Now the}$$

$$\text{height } h \text{ necessary for communicating any velocity } v \text{ is } \frac{v^2}{2g} = \frac{-ag(1+\dot{p}^2)}{2g(n+P)} = \frac{-\frac{1}{2}a(1+\dot{p}^2)}{n+P}. \text{ And lastly,}$$

$$t = \frac{\sqrt{a}}{\sqrt{g}} \int \frac{\dot{p}}{\sqrt{n+P}}.$$

These fluents, being all taken so as to vanish at the vertex, where the computation commences, and where $p=0$ (the tangent being parallel to the horizon), we obtain in this case $h = \frac{\frac{1}{2}a}{n} = \frac{a}{2n}$, and $n = \frac{a}{2h}$.

Hence we see that the circumstance which modifies all the curves, distinguishing them from each other, is the velocity (or rather its square) in the highest point of the curve. For h being determined for any body whose terminal velocity is u , n is also determined; and this is the modifying circumstance. Considering it geometrically, it is the area which must be cut off from the area DMAP of fig. 8. in order to determine the ordinates of the other curves.

We must farther remark, that the values now given relate only to that part of the area where the body is descending from the vertex. This is evident; for, in order that y may increase as we recede from the vertex, its fluxion must be taken in the opposite sense to what it was in our investigation. There we supposed y to increase as the body ascended, and then to diminish during the descent; and therefore the fluxion of y was first positive and then negative.

The same equations, however, will serve for the ascending branch CNA of the curve, only changing the sign of P ; for if we consider y as decreasing during

the ascent, we must consider q as expressing $\frac{-\dot{p}}{x}$ and

therefore P , or $\int \dot{p}\sqrt{1+\dot{p}^2}$, which is $= \frac{q}{a}$, must be

taken negatively. Therefore, in the ascending branch, we have AQ or x (increasing as we recede from A) —

$$a \times \int \frac{\dot{p}}{n-P}, \text{ QN or } y = a \times \int \frac{\dot{p}\dot{p}}{n-P}, \text{ AN or } z =$$

$$a \times \int \frac{\dot{p}\sqrt{1+\dot{p}^2}}{n-P}, t = \frac{\sqrt{a}}{\sqrt{g}} \times \int \frac{\dot{p}}{\sqrt{n-P}}, \text{ and the}$$

height producing the velocity at N $= \frac{\frac{1}{2}a(1+\dot{p}^2)}{n-P}$.

Hence we learn by the bye, that in no part of the ascending branch can the inclination of the tangent be such

81
Remarkable property of the curve

such that P shall be greater than n ; and that if we suppose P equal to n in any point of the curve, the velocity in that point will be infinite. That is to say, there is a certain assignable elevation of the tangent which cannot be exceeded in a curve which has this velocity in the vertex. The best way for forming a conception of this circumstance in the nature of the curve, is to invert the motion, and suppose an accelerating force equal and opposite to the resistance, to act on the body in conjunction with gravity. It must describe the same curve, and this branch ANC must have an asymptote LO , which has this limiting position of the tangent. For, as the body descends in this curve, its velocity increases to infinity by the joint action of gravity and this accelerating force, and yet the tangent never approaches so near the perpendicular position as to make $P=n$. This remarkable property of the curve was known to Newton, as appears by his approximations, which all lead him to curves of a hyperbolic form, having one asymptote inclined to the horizon. Indeed it is pretty obvious: For the resistance increasing faster than the velocity, there is no velocity of projection so great but that the curve will come to deviate so from the tangent, that in a finite time it will become parallel to the horizon. Were the resistance proportional to the velocity, then an infinite velocity would produce a rectilinear motion, or rather a deflection from it less than any that can be assigned.

We now see that the particular form and magnitude of this trajectory depends on two circumstances, a and n . a affects chiefly the magnitude. Another circumstance might indeed be taken in, viz. the diminution of the accelerating force of gravity by the statical effect of the air's gravity. But, as we have already observed, this is too trifling to be attended to in military projectiles.

$\frac{y}{x}$ was made equal to \dot{p} . Therefore the radius of curvature, determined by the ordinary method, is $\frac{x(1+\dot{p}^2)(\sqrt{1+\dot{p}^2})}{\dot{p}}$, and, because $\frac{x}{\dot{p}}$ is

$= \frac{a}{n+P}$ for the descending branch of the curve, the

radius of curvature at M is $\frac{a \times 1 + \dot{p}^2 \times \sqrt{1+\dot{p}^2}}{n+P}$, and,

in the ascending branch at N , it is $\frac{a \times 1 + \dot{p}^2 \times \sqrt{1+\dot{p}^2}}{n-P}$.

On both sides therefore, when the velocity is infinitely great, and P by this means supposed to equal or exceed n , the radius of curvature is also infinitely great. We also see that the two branches are unlike each other, and that when \dot{p} is the same in both, that is, when the tangent is equally inclined to the horizon, the radius of curvature, the ordinate, the absciss, and the arch, are all greater in the ascending branch. This is pretty obvious. For as the resistance acts entirely in diminishing the velocity, and does not affect the deflection occasioned by gravity, it must allow gravity to incurvate the path so much the more (with the same inclination of its line of action) as the velocity is more diminished. The curvature, therefore, in those points which have the same inclination of the tangent, is greatest in the descending branch, and the motion is swiftest in the ascending branch. It is otherwise in a void, where both

sides are alike. Here v becomes infinite, or there is no terminal velocity; and n also becomes infinite, being $= \frac{a}{2b}$.

It is therefore in the quantity P , or $\int \dot{p} \sqrt{1+\dot{p}^2}$, that the difference between the trajectory in a void and in a resisting medium consists; it is this quantity which expresses the accumulated change of the ratio of the increments of the ordinate and absciss. In vacuo the second increment of the ordinate is constant when the first increment of the abscissa is so, and the whole increment of the ordinate is as $1+\dot{p}$. And this difference is so much the greater as P is greater in respect of n . P is nothing at the vertex, and increases along with the angle MTP ; and when this is a right angle, P is infinite. The trajectory in a resisting medium will come therefore to deviate infinitely from a parabola, and may even deviate farther from it than the parabola deviates from a straight line. That is, the distance of the body in a given moment from that point of its parabolic path where it would have been in a void, is greater than the distance between that point of the parabola from the point of the straight line where it would have been, independent of the action of gravity. This must happen whenever the resistance is greater than the weight of the body, which is generally the case in the beginning of the trajectory in military projectiles; and this (were it now necessary) is enough to show the inutility of the parabolic theory.

Although we have no method of describing this trajectory, which would be received by the ancient geometers, we may ascertain several properties of it, which will assist us in the solution of the problem. In particular, we can assign the absolute length of any part of it by means of the logistic curve. For because $P = \int \dot{p} \sqrt{1+\dot{p}^2}$, we have $\dot{p} \sqrt{1+\dot{p}^2} = \dot{P}$, and there-

fore z , which was $= a \times \int \frac{\dot{p} \sqrt{1+\dot{p}^2}}{\dot{p} \sqrt{1+\dot{p}^2}} + C$, or $= a \times \int \frac{\dot{P}}{n+P}$, may be expressed by logarithms; or $z = a$

\times hyp. log. of $\frac{n+P}{n}$, since at the vertex A , where z must be $= 0$, P is also $= 0$.

Being able, in this way, to ascertain the length AM of the curve (counted from the vertex), corresponding to any inclination \dot{p} of the tangent at its extremity M , we can ascertain the length of any portion of it, such as Mm , by first finding the length of the part Am , and then of the part AM . This we do more expeditiously thus: Let \dot{p} express the position of the tangent in M , and q its position at m ; then $AM = a \times \log. \frac{n+P}{n}$ and Am

$= a \times \log. \frac{n+Q}{n}$, and therefore Mm is $= a \times \log.$

$\frac{n+Q}{n+P}$. Thus we can find the values of a great number of small portions, and the inclination of the tangents at their extremities. Then to each of these portions we can assign its proportion of the abscissa and ordinate, without having recourse to the values of x and y . For the portion of absciss corresponding to the arch Mm , whole

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* Simpson's
fluxions,
§ 68, &c.

13.
Several
properties
of it ascer-
tained.

whose middle point is inclined to the horizon in the angle b , will be $Mm \times \cosine b$, and the corresponding portion of the ordinate will be $Mm \times \sin. b$. Then we obtain the velocity in each part of the curve by the equation $b = \frac{1}{2} a \times \frac{1+p^2}{n+p}$; or, more directly the velocity

v at M will be $= \sqrt{ag} \frac{\sqrt{1+p^2}}{\sqrt{n+p}}$. Lastly, divide the

length of the little arch by this, and the quotient will be the time of describing Mm very nearly. Add all these together, and we obtain the whole time of describing the arch AM , but a little too great, because the motion in the small arch is not perfectly uniform. The error, however, may be as small as we please, because we may make the arch as small as we please; and for greater accuracy, it will be proper to take the p by which we compute the velocity, a medium between the p for the beginning and that for the end of the arch.

84
Euler's method preferred.

This is the method followed by Euler, who was one of the most expert analysts, if not the very first, in Europe. It is not the most elegant, and the methods of some other authors, who approximate directly to the areas of the curves which determine the values of x and y , have a more scientific appearance; but they are not ultimately very different: For, in some methods, these areas are taken piecemeal, as Euler takes the arch; and by the methods of others, who give the value of the areas by Newton's method of describing a curve of the parabolic kind through any number of given points, the ordinates of these curves, which express x and y , must be taken singly, which amounts to the same thing, with the great disadvantage of a much more complicated calculus, as any one may see by comparing the expressions of x and y with the expression of z . As to those methods which approximate directly to the areas or values of x and y by an infinite series, they all, without exception, involve us in most complicated expressions, with coefficients of sines and tangents, and ambiguous signs, and engage us in a calculation almost endless. And we know of no series which converges fast enough to give us tolerable accuracy, without such a number of terms as is sufficient to deter any person from the attempt. The calculation of the arches is very moderate, so that a person tolerably versant in arithmetical operations may compute an arch with its velocity and time in about five minutes. We have therefore no hesitation in preferring this method of Euler's to all that we have seen, and therefore proceed to determine some other circumstances which render its application more general.

85
Its application made more general.

If there were no resistance, the smallest velocity would be at the vertex of the curve, and it would immediately increase by the action of gravity conspiring (in however small degree) with the motion of the body. But in a resisting medium, the velocity at the vertex is diminished by a quantity to which the acceleration of gravity in that point bears no assignable proportion. It is therefore diminished, upon the whole, and the point of smallest velocity is a little way beyond the vertex. For the same reasons, the greatest curvature is a little way beyond the vertex. It is not very material for our present purpose to ascertain the exact positions of those points.

The velocity in the descending branch augments continually; but it cannot exceed a certain limit, if the velocity at the vertex has been less than the terminal velocity; for when the curve is infinite, p is also infinite, and

$b = \frac{1}{2} \frac{ap^2}{p}$, because n in this case is nothing in respect of P , which is infinite; and because p is infinite, the number hyp. log. $p + \sqrt{1+p^2}$, though infinite, vanishes in comparison with $p \times \sqrt{1+p^2}$; so that in this case $P = \frac{1}{2} p^2$, and $b = a$, and $v =$ the terminal velocity.

If, on the other hand, the velocity at the vertex has been greater than the terminal velocity, it will diminish continually, and when the curve has become infinite, v will be equal to the terminal velocity.

In either case we see that the curve on this side will have a perpendicular asymptote. It would require a long and pretty intricate analysis to determine the place of this asymptote, and it is not material for our present purpose. The place and position of the other asymptote LO is of the greatest moment. It evidently distinguishes the kind of trajectory from any other. Its position depends on this circumstance, that if p marks the position of the tangent, $n = P$, which is the denominator of the fraction expressing the square of the velocity, must be equal to nothing, because the velocity is infinite: therefore, in this place, $P = n$, or $n =$

$\frac{1}{2} p \sqrt{1+p^2} + \frac{1}{2} \log. p + \sqrt{1+p^2}$. In order, therefore, to find the point L , where the asymptote LO cuts the horizontal line AL , put $P = n$, then will $AL = x - \frac{y}{x} = a \times \left(\int \frac{p}{n-P} - \frac{1}{p} \int \frac{p}{n-P} \right)$.

Through the whole of this article \int means \int_{ent} .

It is evident that the logarithms used in these expressions are the natural or hyperbolic. But the operations may be performed by the common tables by making

the value of the arch Mm of the curve $= \frac{a}{M} \times \log.$

$\frac{n+Q}{n+P}$ &c. where M means the subtangent of the common logarithms, or 0,43429; also the time of describing this arch will be expeditiously had by taking a medium μ between the values of $\frac{\sqrt{1+p^2}}{\sqrt{n+P}}$ and $\frac{\sqrt{1+q^2}}{\sqrt{n+Q}}$,

and making the time $= \frac{\sqrt{a}}{M \mu \sqrt{g}} \times \log. \frac{n+Q}{n+P}$.

Such then is the process by which the form and magnitude of the trajectory, and the motion in it, may be determined. But it does not yet appear how this is to be applied to any question in practical artillery. In this process we have only learned how to compute the motion from the vertex in the descending branch till the ball has acquired a particular direction, and the motion to the vertex from a point of the ascending branch where the ball has another direction, and all this depending on the greatest velocity which the body can acquire by falling, and the velocity which it has in the vertex of the curve. But the usual question is, "What will be the motion of the ball projected in a certain direction with a certain velocity?"

The mode of application is this: Suppose a trajectory computed for a particular terminal velocity, produced by the fall a , and for a particular velocity at the vertex, which

which will be characterized by n , and that the velocity at that point of the ascending branch where the inclination of the tangent is 30° is 900 feet *per* second. Then, we are certain that if a ball, whose terminal velocity is that produced by the fall a , be projected with the velocity of 900 feet per second, and an elevation of 50° , it will describe this very trajectory, and the velocity and time corresponding to every point will be such as is here determined.

Now this trajectory will, in respect to form, answer an infinity of cases: for its characteristic is the proportion of the velocity in the vertex to the terminal velocity. When this proportion is the same, the number n will be the same. If therefore we compute the trajectories for a sufficient variety of these proportions, we shall find a trajectory that will nearly correspond to any case that can be proposed; and an approximation sufficiently exact will be had by taking a proportional medium between the two trajectories which come nearest to the case proposed.

87
Computed
tables or
trajectories

Accordingly, a set of tables or trajectories have been computed by the English translator of Euler's Commentary on Robins's Gunnery. They are in number 18, distinguished by the position of the asymptote of the ascending branch. This is given for 5° , 10° , 15° , &c. to 85° , and the whole trajectory is computed as far as it can ever be supposed to extend in practice. The following table gives the value of the number n corresponding to each position of the asymptote.

OLB	n	OLB	n
0	0,00000	45	1,14779
5	0,08760	50	1,43236
10	0,17724	55	1,82207
15	0,27712	60	2,39033
20	0,37185	65	3,19040
25	0,48269	70	4,88425
30	0,60799	75	8,22357
35	0,75382	80	17,54793
40	0,92914	85	67,12291

Since the path of a projectile is much less incurvated, and more rapid in the ascending than in the descending branch, and the difference is so much the more remarkable in great velocities; it must follow, that the range on a horizontal or inclined plane depends most on the ascending branch: therefore the greatest range will not be made with that elevation which bisects the angle of position, but with a lower elevation; and the deviation from the bisecting elevation will be greater as the initial velocities are greater. It is very difficult to frame an exact rule for determining the elevation which gives the greatest range. We have subjoined a little table which gives the proper elevations (nearly) corresponding to the different initial velocities.

It was computed by the following approximation, which will be found the same with the series used by Newton in his Approximations.

Let e be the angle of elevation, a the height producing the terminal velocity, b the height producing the initial velocity, and c the number whose hyperbolic logarithm is 1 (*i. e.* the number 2,718). Then,

$$y = x \times \left(\tan. e + \frac{a}{2b \cdot \cos. e} \right) - \frac{a^2}{2b} \left(C^{\frac{x}{a \cdot \cos. e}} - 1 \right),$$

&c. Make $y = v$, and take the maximum by varying e , we obtain $\text{Sin.}^2 e + \frac{a \cdot \sin. e}{2b} = \text{hyperbol. log.}$

$\left(1 + \frac{2b}{a \cdot \sin. e} \right)$, which gives us the angle e .

The numbers in the first column, multiplied by the terminal velocity of the projectile, give us the initial velocity; and the numbers in the last column, being multiplied by the height producing the terminal velocity, and by 2,3026, give us the greatest ranges. The middle column contains the elevation. The table is not computed with scrupulous exactness, the question not requiring it. It may however be depended on within one part of 2000.

To make use of this table, divide the initial velocity by the terminal velocity u , and look for the quotient in the first column. Opposite to this will be found the elevation giving the greatest range; and the number in the last column being multiplied by $2,3026 \times a$ (the height producing the terminal velocity) will give the range.

TABLE of Elevations giving the greatest Range.

Initial vel. u	Elevation	Range. $2,3026a^*$
0,6909	$43^\circ.40'$	0,1751
0,7820	43.20	0,2169
0,8645	42.50	0,2548
1,3817	41.40	0,4999
1,5641	40.20	0,5789
1,7291	40.10	0,6551
2,0726	39.50	0,7877
2,3461	37.20	0,8967
2,5936	35.50	0,9752
2,7635	$35. \sim$	1,0319
3,1281	34.40	1,1411
3,4544	34.20	1,2298
3,4581	34.20	1,2277
3,9101	33.50	1,3371
4,1452	33.30	1,3901
4,3227	33.30	1,4274
4,6921	31.50	1,5050
4,8361	31.50	1,5341

Such is the solution which the present state of our mathematical knowledge enables us to give of this celebrated problem. It is exact in its principle, and the application of it is by no means difficult, or even operose. But let us see what advantage we are likely to derive from it.

In the first place, it is very limited in its application. There are few circumstances of general coincidence, and almost every case requires an appropriated calculus. Perhaps the only general rules are the two following:

1. Balls of equal density, projected with the same elevation, and with velocities which are as the square-roots of their diameters, will describe similar curves.— This is evident, because, in this case, the resistance will be in the ratio of their quantities of motion. Therefore all

all the homologous lines of the motion will be in the proportion of the diameters.

2. If the initial velocities of balls projected with the same elevation are in the inverse subduplicate ratio of the whole resistances, the ranges, and all the homologous lines of their track, will be inversely as those resistances.

These theorems are of considerable use: for by means of a proper series of experiments on one ball projected with different elevations and velocities, tables may be constructed which will ascertain the motions of an infinity of others.

89
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from va-
rious con-
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to be very
little.

But when we take a retrospective view of what we have done, and consider the conditions which were assumed in the solution of the problem, we shall find that much yet remains before it can be rendered of great practical use, or even satisfy the curiosity of the man of science. The resistance is all along supposed to be in the duplicate ratio of the velocity; but even theory points out many causes of deviation from this law, such as the pressure and condensation of the air, in the case of very swift motions; and Mr Robins's experiments are sufficient to show us that the deviations must be exceedingly great in such cases. Mr Euler and all subsequent writers have allowed that it may be three times greater, even in cases which frequently occur; and Euler gives a rule for ascertaining with tolerable accuracy what this increase and the whole resistance may amount to. Let H be the height of a column of air whose weight is equivalent to the resistance taken in the duplicate ratio of the velocity. The whole resistance will

be expressed by $H + \frac{H^2}{28845}$. This number 28845 is the height in feet of a column of air whose weight balances its elasticity. We shall not at present call in question his reasons for assigning this precise addition. They are rather reasons of arithmetical convenience than of physical import. It is enough to observe, that if this measure of the resistance is introduced into the process of investigation, it is totally changed; and it is not too much to say, that with this complication it requires the knowledge and address of a Euler to make even a partial and very limited approximation to a solution.—Any law of the resistance, therefore, which is more complicated than what Bernoulli has assumed, namely, that of a simple power of the velocity, is abandoned by all the mathematicians, as exceeding their abilities; and they have attempted to avoid the error arising from the assumption of the duplicate ratio of the velocity, either by supposing the resistance throughout the whole trajectory to be greater than what it is in general, or they have divided the trajectory into different portions, and assigned different resistances to each, which vary, through the whole of that portion, in the duplicate ratio of the velocities. By this kind of patchwork they make up a trajectory and motion which corresponds, in some tolerable degree, with what? With an accurate theory? No; but with a series of experiments. For, in the first place, every theoretical computation that we make, proceeds on a supposed initial velocity; and this cannot be ascertained with any thing approaching to precision, by any theory of the action of gunpowder that we are yet possessed of. In the next place, our theories of the resisting power of the air are en-

tirely established on the experiments on the flights of shot and shells, and are corrected and amended till they tally with the most approved experiments we can find. We do not learn the ranges of a gun by theory, but the theory by the range of the gun. Now the variety and irregularity of all the experiments which are appealed to are so great, and the acknowledged difference between the resistance to slow and swift motions is also so great, that there is hardly any supposition which can be made concerning the resistance, that will not agree in its results with many of those experiments. It appears from the experiments of Dr Hutton of Woolwich, in 1784, 1785, and 1786, that the shots frequently deviated to the right or left of their intended track 200, 300, and sometimes 400 yards. This deviation was quite accidental and anomalous, and there can be no doubt but that the shot deviated from its intended and *supposed* elevation as much as it deviated from the intended vertical plane, and this without any opportunity of measuring or discovering the deviation. Now, when we have the whole range from one to three to choose among for our measure of resistance, it is evident that the confirmations which have been drawn from the ranges of shot are but feeble arguments for the truth of any opinion. Mr Robins finds his measures fully confirmed by the experiments at Metz and at Minorca. Mr Muller finds the same. Yet Mr Robins's measure both of the initial velocity and of the resistance are at least treble of Mr Muller's; but by compensation they give the same results. The Chevalier Borda, a very expert mathematician, has adduced the very same experiments in support of his theory, in which he abides by the Newtonian measure of the resistance, which is about $\frac{1}{3}$ of Mr Robins's, and about $\frac{1}{4}$ of Muller's.

What are we to conclude from all this? Simply this, ⁹⁰ Causes of that we have hardly any knowledge of the air's resistance, and that even the solution given of this problem has ^{its inutility} not as yet greatly increased it. Our knowledge consists only in those experiments, and mathematicians are attempting to patch up some notion of the motion of a body in a resisting medium, which shall tally with them.

There is another essential defect in the conditions assumed in the solution. The density of the air is supposed uniform; whereas we are certain that it is less by one fifth or one sixth towards the vertex of the curve, in many cases which frequently occur, than it is at the beginning and end of the flight. This is another latitude given to authors in their assumptions of the air's resistance. The Chevalier de Borda has, with considerable ingenuity, accommodated his investigation to this circumstance, by dividing the trajectory into portions, and, without much trouble, has made one equation answer them all. We are disposed to think that his solution of the problem (in the Memoirs of the Academy of Paris for 1769) corresponds better with the physical circumstances of the case than any other. But his process is there delivered in too concise a manner to be intelligible to a person not perfectly familiar with all the resources of modern analysis. We therefore preferred John Bernoulli's, because it is elementary and rigorous.

After all, the practical artillerist must rely chiefly on the records of experiments contained in the books of practice

91
Necessity of
attending
to experi-
ments.

practice at the academies, or those made in a more public manner. Even a perfect theory of the air's resistance can do him little service, unless the force of gunpowder were uniform. This is far from being the case even in the same powder. A few hours of a damp day will make a greater difference than occurs in any theory; and, in service, it is only by trial that every thing is performed. If the first shell falls very much short of the mark, a little more powder is added; and, in cannonading, the correction is made by varying the elevation.

We hope to be forgiven by the eminent mathematicians for these observations on their theories. They by no means proceed from any disrespect for their labours. We are not ignorant of the almost insuperable difficulty of the task, and we admire the ingenuity with which some of them have contrived to introduce into their analysis reasonable substitutions for those terms which would render the equations intractable. But we must still say, upon their own authority, that these are but ingenious guesses, and that experiment is the touchstone by which they mould these substitutions; and when they have found a coincidence, they have no motive to make any alteration. Now, when we have such a latitude for our measure of the air's resistance, that we may take it of any value, from one to three, it is no wonder that compensations of errors should produce a coincidence; but where is the coincidence? The theorist *supposes* the ball to set out with a certain velocity, and his theory gives a certain range; and this range agrees with observation—but how? Who knows the velocity of the ball in the experiment? This is concluded from a theory incomparably more uncertain than that of the motion in a resisting medium.

The experiments of Mr Robins and Dr Hutton show, in the most incontrovertible manner, that the resistance to a motion exceeding 1100 feet in a second, is almost *three times* greater than in the duplicate ratio to the resistance to moderate velocities. Euler's translator, in his comparison of the author's trajectories with experiment, supposes it to be *no* greater. Yet the coincidence is very great. The same may be said of the Chevalier de Borda's. Nay, the same may be said of Mr Robins's own practical rules: for he makes his *F*, which corresponds to our *a*, almost double of what these authors do, and yet his rules are confirmed by practice. Our observations are therefore well founded.

92
The theory
is still of
some use in
practice,

But it must not be inferred from all this, that the physical theory is of no use to the practical artillery. It plainly shows him the impropriety of giving the projectile an enormous velocity. This velocity is of no effect after 200 or 300 yards at farthest, because it is so rapidly reduced by the prodigious resistance of the air. Mr Robins has deduced several practical maxims of the greatest importance from what we already know of this subject, and which could hardly have been even conjectured without this knowledge. See GUNNERY.

93
And may
be brought
to greater
perfection.

And it must still be acknowledged, that this branch of physical science is highly interesting to the philosopher; nor should we despair of carrying it to greater perfection. The defects arise almost entirely from our ignorance of the law of variation of the air's resistance. Experiments may be contrived much more conducive to our information here than those commonly resorted

to. The oblique flights of projectiles are, as we have seen, of very complicated investigation, and ill fitted for instructing us; but numerous and well contrived experiments on the perpendicular ascents are of great simplicity, being affected by nothing but the air's resistance. To make them instructive, we think that the following plan might be pursued. Let a set of experiments be premised for ascertaining the initial velocities. Then let shells be discharged perpendicularly with great varieties of density and velocity, and let nothing be attended to but the height and the time; even a considerable deviation from the perpendicular will not affect either of these circumstances, and the effect of this circumstance can easily be computed. The height can be ascertained with sufficient precision for very valuable information by their light or smoke. It is evident that these experiments will give *direct* information of the air's retarding force; and every experiment gives us two measures, viz. the ascent and descent: and the comparison of the times of ascent and descent, combined with the observed height in one experiment made with a great initial velocity, will give us more information concerning the air's resistance than 50 ranges. If we should suppose the resistance as the square of the velocity, this comparison will give in each experiment an exact determination of the initial and final velocities, which no other method can give us. These, with experiments on the *time* of horizontal flights, with known initial velocities, will give us more instruction on this head than any thing that has yet been done; and till something of this kind is carefully done, we presume to say that the motion of bodies in a resisting medium will remain in the hands of the mathematicians as a matter of curious speculation. In the mean time, the rules which Mr Robins has delivered in his Gunnery are very simple and easy in their use, and seem to come as near the truth as any we have met with. He has not informed us upon what principles they are founded, and we are disposed to think that they are rather empirical than scientific. But we profess great deference for his abilities and penetration, and doubt not but that he had framed them by means of as scientific a discussion as his knowledge of this new and difficult subject enabled him to give it.

We shall conclude this article, by giving two or three Tables calculated on the principles established above, and which serve to bring into one point of view the chief circumstances of the motion in a resisting medium. Although the result of much calculation, as any person who considers the subject will readily see, they must not be considered as offering any very accurate results; or that, in comparison with one or two experiments, the differences shall not be considerable. Let any person peruse the published registers of experiments which have been made with every attention, and he will see such enormous irregularities, that all expectations of perfect agreement with them must cease. In the experiments at Woolwich 1735, which were continued for several days, not only do the experiments of one day differ among themselves, but the mean of all the experiments of one day differs from the mean of all the experiments of another no less than one fourth of the whole. The experiments in which the greatest regularity may be expected, are those made with great elevations. When the elevation is small, the range

95
Tables calculated on the preceding principles.

range is more affected by a change of velocity, and still more by any deviation from the supposed or intended direction of the shot.

The first table shows the distance in yards to which a ball projected with the velocity 1600 will go, while its velocity is reduced one tenth, and the distance at which it drops 16 feet from the line of its direction. This table is calculated by the resistance observed in Mr Robins's experiments. The first column is the weight of the ball in pounds. The second column remains the same whatever be the initial velocity; but the third column depends on the velocity. It is here given for the velocity which is very usual in military service, and its use is to assist us in directing the gun to the mark.— If the mark at which a ball of 24 pounds is directed is 474 yards distant, the axis of the piece must be pointed 16 feet higher than the mark. These deflections from the line of direction are nearly as the squares of the distances.

I.	II.	III.
2	92	420
4	121	428
9	159	456
18	200	470
32	272	479

The next table contains the ranges in yards of a 24 pound shot, projected at an elevation of 45°, with the different velocities in feet per second, expressed in the first column. The second column contains the distances to which the ball would go in vacuo in a horizontal plane; and the third contains the distances to which it will go through the air. The fourth column is added, to show the height to which it rises in the air; and the fifth shows the ranges corrected for the diminution of the air's density as the bullet ascends, and may therefore be called the *corrected range*.

I.	II.	III.	IV.	V.
200	416	349	106	360
400	1664	1121	338	1150
600	3740	1812	606	1859
800	6649	2373	866	2435
1000	10390	2845	1138	2919
1200	14961	3259	1378	3343
1400	20364	3640	1606	3734
1600	26597	3950	1814	4050
1800	33663	4235	1992	4345
2000	41559	4494	2168	4610
2200	50286	4720	2348	4842
2400	59846	4917	2460	5044
2600		5106	2630	5238
2800		5293	2762	5430
3000		5455	2862	5596
3200				5732

95
Use of the
table. The initial velocities can never be pushed as far as we have calculated for in this table; but we mean it for a table of more extensive use than appears at first sight. Recollect, that while the proportion of the velocity.

Vol. XV. Part II.

locity at the vertex to the terminal velocity remains the same, the curves will be similar: therefore, if the initial velocities are as the square-roots of the diameters of the balls, they will describe similar curves, and the ranges will be as the diameters of the balls.

Therefore, to have the range of a 12 pound shot, if projected at an elevation of 45°, with the velocity 1500; suppose the diameter of the 12 pounder to be d , and that of the 24 pounder D ; and let the velocities be v and V : Then say, $\sqrt{d} : \sqrt{D} = 1500$, to a fourth proportional V . If the 24 pounder be projected with the velocity V , it will describe a curve similar to that described by the 12 pounder, having the initial velocity 1500. Therefore find (by interpolation) the range of the 24 pounder, having the initial velocity V . Call this R . Then $D : d = R : r$, the range of the 12 pounder which was wanted, and which is nearly 3380 yards.

We see by this table the immense difference between the motions through the air and in a void. We see that the ranges through the air, instead of increasing in the duplicate ratio of the initial velocities, really increase slower than those velocities in all cases of military service; and in the most usual cases, viz. from 800 to 1600, they increase nearly as the square-roots of the velocities.

A set of similar tables, made for different elevations, would almost complete what can be done by theory, and would be much more expeditious in their use than Mr Euler's Trajectories, computed with great labour by his English translator.

The same table may also serve for computing the ranges of bomb-shells. We have only to find what must be the initial velocity of the 24 pound shot which corresponds to the proposed velocity of the shell. This must be deduced from the diameter and weight of the shell, by making the velocity of the 24 pounder such, that the ratio of its weight to the resistance may be the same as in the shell.

That the reader may see with one glance the relation of those different quantities, we have given this table, expressed in a figure (fig. 10). The abscissa, or axis DA, is the scale of the initial velocities in feet per second, measured on a scale of 400 equal parts in an inch. The ordinates to the curve ACG express the yards of the range on a scale containing 800 yards in an inch. The ordinates to the curve Axy express (by the same scale) the height to which the ball rises in the air.

The ordinate BC (drawn through the point of the abscissa which corresponds to the initial velocity 2000) is divided in the points 4, 9, 12, 18, 24, 32, 42, in the ratio of the diameters of cannon-shot of different weights; and the same ordinate is produced on the other side of the axis, till BO be equal to BA; and then BO is divided in the subduplicate ratio of the same diameters. Lines are drawn from the point A, and from any point D of the abscissa, to these divisions.

We see distinctly by this figure how the effect of the initial velocity gradually diminishes, and that in very great velocities the range is very little increased by its augmentation. The dotted curve APQR, shows what the ranges in vacuo would be.

By this figure may the problems be solved. Thus, to find the range of the 12 pounder, with the initial velocity

4 C

velocity

Plate
cccxcviii.
96

Relation of
the differ-
ent quan-
tities in it.

velocity 1500. Set off 1500 from B to F; draw FH parallel to the axis, meeting the line 12A in H; draw the ordinate HK; draw KL parallel to the axis, meeting 24 B in L; draw the ordinate LM, cutting 12 B in N. MN is the range required.

If curves, such as ACG, were laid down in the same manner for other elevations, all the problems might be solved with great dispatch, and with much more accuracy than the theory by which the curves are drawn can pretend to.

PROJECTION OF THE SPHERE.

Stereographic Projection of the Sphere.

THE PROJECTION of the SPHERE is a perspective representation of the circles on the surface of the sphere; and is variously denominated according to the different positions of the eye and plane of projection.

There are three principal kinds of projection; the *stereographic*, the *orthographic*, and *gnomonic*. In the *stereographic* projection the eye is supposed to be placed on the surface of the sphere; in the *orthographic* it is supposed to be at an infinite distance; and in the *gnomonic* projection the eye is placed at the centre of the sphere. Other kinds of projection are, the *globular*, *Mercator's*, *senographic*, &c. for which see the articles *GEOGRAPHY*, *NAVIGATION*, *PERSPECTIVE*, &c.

DEFINITIONS.

1. The plane upon which the circles of the sphere are described, is called the *plane of projection*, or the *primitive circle*. The pole of this circle is the *pole of projection*, and the place of the eye is the *projecting point*.
2. The *line of measures* of any circle of the sphere is that diameter of the primitive, produced indefinitely, which passes through the centre of the projected circle.

AXIOM.

The projection, or representation of any point, is where the straight line drawn from it to the projecting point intersects the plane of projection.

SECTION I.

Of the Stereographic Projection of the Sphere.

In the *stereographic* projection of the sphere, the eye is placed on the surface of the sphere in the pole of the great circle upon which the sphere is to be projected. The projection of the hemisphere opposite to the eye falls within the primitive, to which this projection is generally limited: it, however, may be extended to the other hemisphere, or that wherein the eye is placed, the projection of which falls without the primitive.

As all circles in this projection are projected either into circles or straight lines, which are easily described, it is therefore more generally understood, and by many preferred to the other projections.

PROPOSITION I. THEOREM I.

Every great circle which passes through the projecting point is projected into a straight line passing through the centre of the primitive; and every arch of it, reckoned from the other pole of the primitive, is projected into its semitangent.

Let ABCD (fig. 1.) be a great circle passing thro' A, C, the poles of the primitive, and intersecting it in the line of common section BED, E being the centre of the sphere. From A, the projecting point, let there be drawn straight lines AP, AM, AN, AQ, to any number of points P, M, N, Q, in the circle ABCD: these lines will intersect BED, which is in the same plane with them. Let them meet it in the points p, m, n, q ; then p, m, n, q , are the projections of P, M, N, Q: hence the whole circle ABCD is projected into the straight line BED, passing through the centre of the primitive.

Again, because the pole C is projected into E, and the point M into m ; therefore the arch CM is projected into the straight line Em, which is the semitangent of the arch CM to the radius AE. In like manner, the arch CP is projected into its semitangent Ep, &c.

COROLLARIES.

1. Each of the quadrants contiguous to the projecting point is projected into an indefinite straight line, and each of those that are remote into a radius of the primitive.
2. Every small circle which passes through the projecting point is projected into that straight line which is its common section with the primitive.
3. Every straight line in the plane of the primitive, and produced indefinitely, is the projection of some circle on the sphere passing through the projecting point.
4. The projection of any point in the surface of the sphere, is distant from the centre of the primitive, by the semitangent of the distance of that point from the pole opposite to the projecting point.

PROPOSITION II. THEOREM II.

Every circle on the sphere which does not pass through the projecting point is projected into a circle.

If the given circle be parallel to the primitive, then a straight line drawn from the projecting point to any point in the circumference, and made to revolve about the circle, will describe the surface of a cone; which being cut by the plane of projection parallel to the base, the section will be a circle. See *CONIC SECTIONS*.

But if the circle MN (fig. 2.) be not parallel to the primitive circle BD, let the great circle ABCD, passing through the projecting point, cut it at right angles in the diameter MN, and the primitive in the diameter BD. Through M, in the plane of the great circle, let MF be drawn parallel to BD; let AM, AN be joined, and

Stereographic Projection of the Sphere. Plate CCCCXIX.

and meet BD in *m. n.* Then, because AB, AD are quadrants, and BD, MF parallel, the arch AM is equal to AF, and the angle AMF or *Amn* is equal to ANM. Hence the conic surface described by the revolution of AM about the circle MN is cut by the primitive in a subcontrary position; therefore the section is in this case likewise a circle.

COROLLARIES.

1. The centres and poles of all circles parallel to the primitive have their projections in its centre.

2. The centre and poles of every circle inclined to the primitive have their projections in the line of measures.

3. All projected great circles cut the primitive in two points diametrically opposite; and every circle in the plane of projection, which passes through the extremities of a diameter of the primitive, or through the projections of two points that are diametrically opposite on the sphere, is the projection of some great circle.

4. A tangent to any circle of the sphere, which does not pass through the projecting point, is projected into a tangent to that circle's projection; also, the circular projections of tangent circles touch one another.

5. The extremities of the diameter, on the line of measures of any projected circle, are distant from the centre of the primitive by the semitangents of the least and greatest distances of the circle on the sphere, from the pole opposite to the projecting point.

6. The extremities of the diameter, on the line of measures of any projected great circle, are distant from the centre of the primitive by the tangent and cotangent of half the great circle's inclination to the primitive.

7. The radius of any projected circle is equal to half the sum, or half the difference of the semitangents of the least and greatest distances of the circle from the pole opposite to the projecting point, according as that pole is within or without the given circle.

PROPOSITION III. THEOREM III.

An angle formed by two tangents at the same point in the surface of the sphere, is equal to the angle formed by their projections.

Plate
cccxcix

Let FGI and GH (fig. 3.) be the two tangents, and A the projecting point; let the plane AGF cut the sphere in the circle AGL, and the primitive in the line BML. Also, let MN be the line of common section of the plane AGH with the primitive: then the angle FGH=LMN. If the plane FGH be parallel to the primitive BLD, the proposition is manifest. If not, through any point K in AG produced, let the plane FKH, parallel to the primitive, be extended to meet FGH in the line FH. Then, because the plane AGF meets the two parallel planes BLD, FKH, the lines of common section LM, FK are parallel; therefore the angle AML=AKF. But since A is the pole of BLD, the chords, and consequently the arches AB, AL, are equal, and the arch ABG is the sum of the arches AL, BG; hence the angle AML is equal to an angle at the circumference standing upon AG, and therefore equal to AGI or FCK; consequently the angle FGK=FCK, and the side FG=FK. In

like manner HG=HK: hence the triangles GHF, KHF are equal, and the angle FGH=FKH=LMN.

COROLLARIES.

1. An angle contained by any two circles of the sphere is equal to the angle formed by their projections. For the tangents to these circles on the sphere are projected into straight lines, which either coincide with, or are tangents to, their projections on the primitive.

2. An angle contained by any two circles of the sphere is equal to the angle formed by the radii of their projections at the point of intersection.

PROPOSITION IV. THEOREM IV.

The centre of a projected great circle is distant from the centre of the primitive; the tangent of the inclination of the great circle to the primitive, and its radius, is the secant of its inclination.

Let MNG (fig. 4.) be the projection of a great circle, meeting the primitive in the extremities of the diameter MN, and let the diameter BD, perpendicular to MN, meet the projection in F, G. Bisect FG in H, and join NH. Then, because any angle contained by two circles of the sphere is equal to the angle formed by the radii of their projections at the point of intersection; therefore the angle contained by the proposed great circle and the primitive is equal to the angle ENH, of which EH is the tangent, and NH the secant, to the radius of the primitive.

COROLLARIES.

1. All circles which pass through the points M, N are the projections of great circles, and have their centres in the line BG; and all circles which pass through the points F, G are the projections of great circles, and have their centres in the line HI, perpendicular to BG.

2. If NF, NH be continued to meet the primitive in L, F; then BL is the measure of the great circle's inclination to the primitive; and $MF=2BL$.

PROPOSITION V. THEOREM V.

The centre of projection of a less circle perpendicular to the primitive, is distant from the centre of the primitive, the secant of the distance of the less circle from its nearest pole; and the radius of projection is the tangent of that distance.

Let MN (fig. 5.) be the given less circle perpendicular to the primitive, and A the projecting point. Draw AM, AN to meet the diameter BD produced in G and H; then GH is the projected diameter of the less circle: bisect GH in C, and C will be its centre; join NE, NC. Then because AE, NI are parallel, the angle INE=NEA; but $NEA=2NMA=2NHG=2NCG$: hence $ENC=INE+INC=NCG+INC$ =a right angle; and therefore NC is a tangent to the primitive at N; but the arch ND is the distance of the less circle from its nearest pole D: hence NC is the tangent, and EC the secant of the distance of the less circle from its pole to the radius of the primitive.

PROJECTION OF THE SPHERE.

PROPOSITION VI. THEOREM VI.

The projection of the poles of any circle, inclined to the primitive, are, in the line of measures, distant from the centre of the primitive, the tangent, and cotangent, of half its inclination.

Plate
CCCCXIX.

Let MN (fig. 6.) be a great circle perpendicular to the primitive ABCD, and A the projecting point; then P, p are the poles of MN, and of all its parallels $m n$, &c. Let AP, A p meet the diameter BD in F, f , which will therefore be the projected poles of MN and its parallels. The angle BEM is the inclination of the circle MEN, and its parallels, to the primitive: and because BC and MP are quadrants, and MC common to both; therefore PC = BM: and hence PEC is also the inclination of MN and its parallels. Now EF is the tangent of EAF, or of half the angle PEC the inclination; and E f is the tangent of the angle EA f ; but EA f is the complement of EAF, hence E f is the cotangent of half the inclination.

COROLLARIES.

1. The projection of that pole which is nearest to the projecting point is without the primitive, and the projection of the other within.
2. The projected centre of any circle is always between the projection of its nearest pole and the centre of the primitive; and the projected centres of all circles are contained between their projected poles.

PROPOSITION VII. THEOREM VII.

Equal arches of any two great circles of the sphere will be intercepted between two other circles drawn on the sphere through the remote poles of those great circles.

Let AGB, CFD (fig. 7.) be two great circles of the sphere, whose remote poles are E, P; through which draw the great circle PBEC, and less circle PGE, intersecting the great circles AGB, CFD, in the points B, G, and D, F; then the arch BG is equal to the arch DF.

Because E is the pole of the circle AGB, and P the pole of CFD, therefore the arches EB, PD are equal; and since BD is common to both, hence the arch ED is equal to the arch PB. For the same reason, the arches EF, PG are equal; but the angle DEF is equal to the angle BPG: hence these triangles are equal, and therefore the arch DF is equal to the arch BG.

PROPOSITION VIII. THEOREM VIII.

If from either pole of a projected great circle, two straight lines be drawn to meet the primitive and the projection, they will intercept similar arches of these circles.

On the plane of projection AGB (fig. 7.) let the great circle CFD be projected into $cf d$, and its pole P into p ; through p draw the straight lines $p d$, $p f$, then are the arches GB, $f d$ similar.

Since $p d$ lies both in the plane AGB and APBE, it is in their common section, and the point B is also in their common section; therefore $p d$ passes through the point B. In like manner it may be shown that the line $p f$ passes through G. Now the points D, F

are projected into d, f : hence the arches FD, $f d$ are similar; but GB is equal to FD, therefore the intercepted arch of the primitive GB is similar to the projected arch $f d$.

COROLLARY.

Hence, if from the angular point of a projected spherical angle two straight lines be drawn through the projected poles of the containing sides, the intercepted arch of the primitive will be the measure of the spherical angle.

PROPOSITION IX. PROBLEM I.

To describe the projection of a great circle through two given points in the plane of the primitive.

Let P and B be given points, and C the centre of the primitive.

1. When one point P (fig. 8.) is the centre of the primitive, a diameter drawn through the given points will be the great circle required.

2. When one point P (fig. 9.) is in the circumference of the primitive. Through P draw the diameter PD; and an oblique circle described through the three points P, B, D, will be the projection of the required great circle.

3. When the given points are neither in the centre nor circumference of the primitive. Through either of the given points P (fig. 10) draw the diameter ED, and at right angles thereto draw the diameter FG. From F through P draw the straight line FPH, meeting the circumference in H: draw the diameter HI, and draw the straight line FIK, meeting ED produced in D; then an arch, terminated by the circumference, being described through the three points P, B, K, will be the great circle.

PROPOSITION X. PROBLEM II.

To describe the representation of a great circle about any given point as a pole.

Let P be the given pole, and C the centre of the primitive.

1. When P (fig. 8.) is in the centre of the primitive, then the primitive will be the great circle required.

2. When the pole P (fig. 11) is in the circumference of the primitive. Through P draw the diameter PE, and the diameter AB drawn at right angles to PE will be the projected great circle required.

3. When the given pole is neither in the centre nor circumference of the primitive. Through the pole P (fig. 12.) draw the diameter AB, and draw the diameter DE perpendicular to AB; through E and P draw the straight line EPF, meeting the circumference in F. Make FG equal to FD; through E and G draw the straight line EGH, meeting the diameter AB produced if necessary in H; then from the centre H, with the radius HE, describe the oblique circle DIE, and it will be the projection of the great circle required.

Or, make DK equal to FA; join EK, which intersects the diameter AB in I; then through the three points D, I, E, describe the oblique circle DIE.

PROPOSITION XI. PROBLEM III.

To find the poles of a great circle.

1. When the given great circle is the primitive, its centre is the pole.

2. To

Stereographic Projection of the Sphere.

Plate
CCCCXIX.
Plate
CCCCXX

2. To find the pole of the right circle ACB (fig. 11.) Draw the diameter PE perpendicular to the given circle AB; and its extremities P, E are the poles of the circle ACB.

3. To find the pole of the oblique circle DEF (fig. 13.) Join DF, and perpendicular thereto draw the diameter AB, cutting the given oblique circle DEF in E. Draw the straight line FEG, meeting the circumference in G. Make GI, GH, each equal to AD; then FI being joined, cuts the diameter AB in P, the lower pole; through F and H draw the straight line FH ρ , meeting the diameter AB produced in ρ , which will be the opposite or exterior pole.

PROPOSITION XII. PROBLEM IV.

To describe a less circle about any given point as a pole, and at any given distance from that pole.

1. When the pole of the less circle is in the centre of the primitive; then from the centre of the primitive, with the semitangent of the distance of the given circle from its pole, describe a circle, and it will be the projection of the less circle required.

2. If the given pole is in the circumference of the primitive, from C (fig. 14.), the centre of the primitive, set off CE the secant of the distance of the less circle from its pole P; then from the centre E, with the tangent of the given distance, describe a circle, and it will be the less circle required. Or, make PG, PF each equal to the chord of the distance of the less circle from its pole. Through B, G, draw the straight line BGD meeting CP produced in D: bisect GD in H, and draw HE perpendicular to GD; and meeting PD in E, then E is the centre of the less circle.

3. When the given pole is neither in the centre nor circumference of the primitive. Through P (fig. 15.), the given pole, and C the centre of the primitive, draw the diameter AB, and draw the diameter DE perpendicular to AB; join EP, and produce it to meet the primitive in ρ ; make ρ F, ρ G, each equal to the chord of the distance of the less circle from its pole; join EF which intersects the diameter AB in H; from E through G draw the straight line EGI, meeting the diameter AB produced in I; bisect HI in K: Then a circle described from the centre K, at the distance KH or KI, will be the projection of the less circle.

PROPOSITION XIII. PROBLEM V.

To find the poles of a given less circle.

The poles of a less circle are also those of its parallel great circle. If therefore the parallel great circle be given, then its poles being found by Prob. III. will be those of the less circle. But if the parallel great circle be not given, let HMIN (fig. 15.) be the given less circle. Through its centre, and C the centre of the primitive, draw the line of measures LAHB; and draw the diameter DE perpendicular to it, also draw the straight line EHF meeting the primitive in F; make F equal to the chord of the distance of the less circle from its pole; join E ρ , and its intersection P with the diameter AB is the interior pole. Draw the diameter CL through E and L, draw EL q meeting the diameter AB produced in q ; then q is the external pole. Or thus: Join EI intersecting the primitive in G; join also EH, and produce it to meet the primitive in F, bisect

the arch GF in ρ ; from E to ρ draw the straight line EP ρ , and P is the pole of the given less circle.

PROPOSITION XIV. PROBLEM VI.

To measure any arch of a great circle.

1. Arches of the primitive are measured on the line of chords.

2. Right circles are measured on the line of semitangents, beginning at the centre of the primitive. Thus, the measure of the portion AC (fig. 16.) of the right circle DE, is found by applying it to the line of semitangents. The measure of the arch DB is found by subtracting that of BC from 90° : the measure of the arch AF, lying partly on each side of the centre, is obtained by adding the measures of AC and CF. Lastly, To measure the part AB, which is neither terminated at the centre or circumference of the primitive, apply CA to the line of semitangents; then CB, and the difference between the measures of these arches, will be that of AB.

Or thus, Draw the diameter GH perpendicular to DE; then from either extremity, as D, of this diameter, draw lines through the extremities of the arch intended to be measured; and the intercepted portion of the primitive applied to the line of chords will give the measure of the required arch. Thus IK applied to the line of chords will give the measure of AB.

3. To measure an arch of an oblique circle: draw lines from its pole through the extremities of the arch to meet the primitive, then the intercepted portion of the primitive applied to the line of chords will give the measure of the arch of the oblique circle. Thus, let AB (fig. 17.), be an arch of an oblique circle to be measured, and P its pole; from P draw the lines PAD, PBE meeting the primitive in B and E; then the arch DE applied to the line of chords will give the measure of the arch of the oblique circle AB.

PROPOSITION XV. PROBLEM VII.

To measure any arch of a less circle.

Let DEG (fig. 18.) be the given less circle, and DE the arch to be measured: find its internal pole P; and describe the circle AFI parallel to the primitive, and whose distance from the projecting point may be equal to the distance of the given less circle from its pole P: then join PD, PE, which produce to meet the parallel circle in A and F. Now AF applied to a line of chords will give the measure of the arch DE of the given less circle.

PROPOSITION XVI. PROBLEM VIII.

To measure any spherical angle.

1. If the angle is at the centre of the primitive, it is measured as a plane angle.

2. When the angular point is in the circumference of the primitive; let A (fig. 19.) be the angular point, and ABE an oblique circle inclined to the primitive. Through P, the pole of ABE, draw the line ρ P meeting the circumference in ρ ; then the arch E ρ is the measure of the angle BAD, and the arch AF ρ is the measure of its supplement BAF: also ρ F is the measure of the angle BAC, and ρ ED that of its supplement.

3. If

Stereographic Projection of the Sphere.

PROJECTION OF THE SPHERE.

SECT. I.

Stereographic Projection of the Sphere.

Plate CCCCXX.

3. If the angular point is neither at the centre nor circumference of the primitive. Let A (fig. 20.) be the angular point, and DAH , or GAF the angle to be measured, P the pole of the oblique circle DAF , and p the pole of GAF : then from A , through the points P & p , draw the straight lines APM , ApN , and the arch MN will be the measure of the angle DAH ; and the supplement of MN will be the measure of the angle HAF or DAG .

PROPOSITION XVII. PROBLEM IX.

To draw a great circle perpendicular to a projected great circle, and through a point given in it.

Find the pole of the given circle, then a great circle described through that pole and the given point will be perpendicular to the given circle. Hence if the given circle be the primitive, then a diameter drawn through the given point will be the required perpendicular. If the given circle is a right one, draw a diameter at right angles to it; then through the extremities of this diameter and the given point describe an oblique circle, and it will be perpendicular to that given. If the given circle is inclined to the primitive, let it be represented by BAD (fig. 21.), whose pole is P , and let A be the point through which the perpendicular is to be drawn: then, by Prob. I. describe a great circle through the points P and A , and it will be perpendicular to the oblique circle BAD .

PROPOSITION XVIII. PROBLEM X.

Through a point in a projected great circle, to describe another great circle to make a given angle with the former, provided the measure of the given angle is not less than the distance between the given point and circle.

Let the given circle be the primitive, and let A (fig. 19.) be the angular point. Draw the diameters AE , DF perpendicular to each other; and make the angle CAG equal to that given, or make CG equal to the tangent of the given angle; then from the centre G , with the distance GC , describe the oblique circle ABE , and it will make with the primitive an angle equal to that given.

If the given circle be a right one, let it be APB (fig. 22.) and let P be the given point. Draw the diameter GH perpendicular to AB ; join GP , and produce it to a ; make Hb equal to twice Aa ; and Gb being joined intersects AB in C . Draw CD perpendicular to AB , and equal to the cotangent of the given angle to the radius PC ; or make the angle CPD equal to the complement of that given: then from the centre D , with the radius DP , describe the great circle FPE , and the angle APF , or BPE , will be equal to that given.

If APB (fig. 23.) is an oblique circle. From the angular point P , draw the lines PG , PC through the centres of the primitive and given oblique circle. Through C , the centre of APB , draw GCD at right angles to PG ; make the angle CPD equal to that given; and from the centre D , with the radius DP , describe the oblique circle FPE , and the angle APF , or BPE , will be equal to that proposed.

PROPOSITION XIX. PROBLEM XI.

Any great circle cutting the primitive being given, to

describe another great circle which shall cut the given one in a proposed angle, and have a given arch intercepted between the primitive and given circles.

If the given circle be a right one, let it be represented by APC (fig. 24.); and at right angles thereto draw the diameter BPM ; make the angle BPF equal to the complement of the given angle, and PF equal to the tangent of the given arch; and from the centre of the primitive with the secant of the same arch describe the arch Gg . Through F draw FG parallel to AC , meeting Gg in G ; then from the centre G , with the tangent PF , describe an arch no , cutting APC in I , and join GI . Through G , and the centre P , draw the diameter HK ; draw PL perpendicular to HK , and IL perpendicular to GI , meeting PL in L ; then L will be the centre of the circle HIK , which is that required.

But if the given great circle be inclined to the primitive, let it be ADB (fig. 25.), and E its centre: make the angle BDF equal to the complement of that given, and DF equal to the tangent of the given arch, as before. From P , the centre of the primitive, with the secant of the same arch, describe the arch Gg , and from E , the centre of the oblique circle, with the extent EF , describe an arch intersecting Gg in G . Now G being determined, the remaining part of the operation is performed as before.

When the given arch exceeds 90° , the tangent and secant of its supplement are to be applied on the line DF the contrary way, or towards the right; the former construction being reckoned to the left.

PROPOSITION XX. PROBLEM XII.

Any great circle in the plane of projection being given to describe another great circle, which shall make given angles with the primitive and given circles.

Let ADC (fig. 26.) be the given circle, and Q its pole. About P , the pole of the primitive, describe an arch mn , at the distance of as many degrees as are in the angle which the required circle is to make with the primitive. About Q the pole of the circle ADC , and at a distance equal to the measure of the angle which the required circle is to make with the given circle ADC , describe an arch on , cutting mn in n . Then about n as a pole, describe the great circle EDF , cutting the primitive and given circle in E and D , and it will be the great circle required.

SCHOLIUM.

It will hence be an easy matter to construct all the various spherical triangles. The reader is, however, referred to the article *Spherical Trigonometry*, for the method of constructing them agreeable to this projection; and also for the application to the resolution of problems of the sphere. For the method of projecting the sphere upon the plane of the meridian, and of the horizon, according to the stereographic projection, see the article *GEOGRAPHY*.

SECTION II.

Of the Orthographic Projection of the Sphere.

THE orthographic projection of the sphere, is that in which the eye is placed in the axis of the plane of projection

Orthographic Projection of the Sphere.

jection, at an infinite distance with respect to the diameter of the sphere; so that at the sphere all the visual rays are assumed parallel, and therefore perpendicular to the plane of projection.

Hence the orthographic projection of any point is where a perpendicular from that point meets the plane of projection: and the orthographic representation of any object is the figure formed by perpendiculars drawn from every point of the object to the plane of projection.

This method of projection is used in the geometrical delineation of eclipses, occultations, and transits. It is also particularly useful in various other projections, such as the analemma. See GEOGRAPHY, &c.

PROPOSITION I. THEOREM I.

Every straight line is projected into a straight line. If the given line be parallel to the plane of projection, it is projected into an equal straight line; but if it is inclined to the primitive, then the given straight line will be to its projection in the ratio of the radius to the cosine of inclination.

Plate CCCXXI.

Let AB (fig. 27.) be the plane of projection, and let CD be a straight line parallel thereto: from the extremities C, D of the straight line CD, draw the lines CE, DF perpendicular to AB; then by 3. of XI. of Eucl. the intersection EF, of the plane CEFD, with the plane of projection, is a straight line: and because the straight lines CD, EF are parallel, and also CE, DF; therefore, by 34. of I. of Eucl. the opposite sides are equal; hence the straight line CD, and its projection EF, are equal. Again, let GH be the proposed straight line, inclined to the primitive; then the lines GE, HF being drawn perpendicular to AB, the intercepted portion EF will be the projection of GH. Through G draw GI parallel to AB, and the angle IGH will be equal to the inclination of the given line to the plane of projection. Now GH being the radius, GI, or its equal EF, will be the cosine of IGH; hence the given line GH is to its projection EF as radius to the cosine of inclination.

COROLLARIES.

1. A straight line perpendicular to the plane of projection is projected into a point.
2. Every straight line in a plane parallel to the primitive is projected into an equal and parallel straight line.
3. A plane angle parallel to the primitive is projected into an equal angle.
4. Any plane rectilinear figure parallel to the primitive is projected into an equal and similar figure.
5. The area of any rectilinear figure is to the area of its projection as radius to the cosine of its inclination.

PROPOSITION II. THEOREM II.

Every great circle, perpendicular to the primitive, is projected into a diameter of the primitive; and every arch of it, reckoned from the pole of the primitive, is projected into its sine.

Let BFD (fig. 28.) be the primitive, and ABCD a great circle perpendicular to it, passing through its poles A, C; then the diameter BED, which is their

line of common section, will be the projection of the circle ABCD. For if from any point, as G, in the circle ABC, a perpendicular GH fall upon BD, it will also be perpendicular to the plane of the primitive: therefore H is the projection of G. Hence the whole circle is projected into BD, and any arch AG into EH equal to GI its sine

COROLLARIES.

1. Every arch of a great circle, reckoned from its intersection with the primitive, is projected into its versed sine.
2. Every less circle perpendicular to the primitive is projected into its line of common section with the primitive, which is also its own diameter; and every arch of the semicircle above the primitive, reckoned from the middle point, is projected into its sine.
3. Every diameter of the primitive is the projection of a great circle; and every chord the projection of a less circle.
4. A spherical angle at the pole of the primitive is projected into an equal angle.

PROPOSITION III. THEOREM III.

A circle parallel to the primitive is projected into a circle equal to itself, and concentric with the primitive.

Let the less circle FIG (fig. 29.) be parallel to the plane of the primitive BND. The straight line HE, which joins their centres, is perpendicular to the primitive; therefore E is the projection of H. Let any radii HI and IN perpendicular to the primitive be drawn. Then IN, HE being parallel, are in the same plane; therefore IH, NE, the lines of common section of the plane IE, with two parallel planes, are parallel; and the figure IHEN is a parallelogram. Hence NE = IH, and consequently FIG is projected into an equal circle KNL, whose centre is E.

COROLLARY.

The radius of the projection is the cosine of the distance of the parallel circle from the primitive, or the sine of its distance from the pole of the primitive.

PROPOSITION IV. THEOREM IV.

An inclined circle is projected into an ellipse, whose transverse axis is the diameter of the circle.

1. Let ELF (fig. 30.) be a great circle inclined to the primitive EBF, and EF their line of common section. From the centre C, and any other point K, in EF, let the perpendiculars CB, KI be drawn in the plane of the primitive, and CL, KN, in the plane of the great circle, meeting the circumference in L, N. Let LG, ND be perpendicular to CB, KI; then G, D are the projections of L, N. And because the triangles LCG, NKD are equiangular, $CL^2 : CG^2 :: NK^2 : DK^2$; or $EC^2 : CG^2 :: EK^2 : DK^2$: therefore the points G, D are in the curve of an ellipse, of which EF is the transverse axis, and CG the semiconjugate axis.

COROLLARIES.

1. In a projected great circle, the semiconjugate axis is the cosine of the inclination of the great circle to the primitive.

PROJECTION OF THE SPHERE.

Sect. II.

Orthographic Projection of the Sphere.

2. Perpendiculars to the transverse axis intercept corresponding arches of the projection and the primitive.

3. The eccentricity of the projection is the sine of the inclination of the great circle to the primitive.

Case 2. Let AQB (fig. 31.) be a less circle, inclined to the primitive, and let the great circle LBM , perpendicular to both, intersect them in the lines AB, LM . From the centre O , and any other point N in the diameter AB , let the perpendiculars TOP, NQ , be drawn in the plane of the less circle, to meet its circumference in T, P, Q . Also, from the points A, N, O, B , let AG, NI, OC, BH , be drawn perpendicular to LM ; and from P, Q, T , draw PE, QD, TF perpendicular to the primitive; then G, I, C, H, E, D, F , are the projections of these points. Because OP is perpendicular to LBM , and OC, PE , being perpendicular to the primitive, are in the same plane, the plane $COPE$ is perpendicular to LBM . But the primitive is perpendicular to LBM ; therefore the common section EC is perpendicular to LBM , and to LM . Hence CP is a parallelogram, and $EC = OP$. In like manner, FC, DI , are proved perpendicular to LM , and equal to OT, NQ . Thus, ECF is a straight line, and equal to the diameter PT . Let QR, DK be parallel to AB, LM ; then $RO = NQ = DI = KC$, and $PR \times RT = EK \times KF$. But $AO : CG :: NO : CI$; therefore $AO^2 : CG^2 :: QR^2 : DK^2$ and $EC^2 : CG^2 :: EKF : DK^2$.

COROLLARIES.

1. The transverse axis is to the conjugate as radius to the cosine of the circle's inclination to the primitive.

2. Half the transverse axis is the cosine of half the sum of the greatest and least distances of the less circle from the primitive.

3. The extremities of the conjugate axis are in the line of measures distant from the centre of the primitive by the cosines of the greatest and least distances of the less circle from the primitive.

4. If from the extremities of the conjugate axis of any elliptical projection perpendiculars be drawn (in the same direction if the circle do not intersect the primitive, but if otherwise in opposite directions), they will intersect an arch of the primitive, whose chord is equal to the diameter of the circle.

PROPOSITION V. THEOREM V.

The projected poles of an inclined circle are in its line of measures distant from the centre of the primitive the sine of the inclination of the circle to the primitive.

Let $ABCD$ (fig 32.) be a great circle, perpendicular both to the primitive and the inclined circle, and intersecting them in the diameters AC, MN . Then $ABCD$ passes through the poles of the inclined circle; let these be P, Q ; and let Pp, Qq , be perpendicular to AC ; p, q are the projected poles; and it is evident that $pO = \text{sine of } BP$, or MA , the inclination.

COROLLARIES.

1. The centre of the primitive, the centre of the projection, the projected poles, and the extremities of the conjugate axis, are all in one and the same straight line.

2. The distance of the centre of projection from the

centre of the primitive, is to the cosine of the distance of the circle from its own pole, as the sine of the circle's inclination to the primitive is to the radius.

PROPOSITION VI. PROBLEM I.

To describe the projection of a circle perpendicular to the primitive, and whose distance from its pole is equal to a given quantity.

Let $PApB$ (fig. 33.) be the primitive circle, and P, p the poles of the right circle to be projected. Then if the circle to be projected is a great circle, draw the diameter AB at right angles to the axis Pp , and it will be that required. But if the required projection is that of a less circle, make PE, PF each equal to the chord of the distance of the less circle from its pole; join EF , and it will be the projection of the less circle required.

PROPOSITION VII. PROBLEM II.

Through a given point in the plane of the primitive to describe the projection of a great circle, having a given inclination to the primitive.

1. When the given inclination is equal to a right angle, a straight line drawn through the centre of the primitive and the given point will be the projection required.

2. When the given inclination is less than a right angle, and the given point in the circumference of the primitive. Let R (fig. 34.) be a point given in the circumference of the primitive, through which it is required to draw the projection of a great circle, inclined to the primitive in an angle measured by the arch QP of the primitive.

Through the given point R draw the diameter RCS , and draw GCg at right angles to it. Make the arch GV of the primitive equal to QP , and draw VA at right angles to GC ; and in Gg , towards the opposite parts of C , take CB equal to AC ; then, with the greater axis RS , and less axis AB , describe an ellipse, and it will be the projection of the oblique circle required.

3. When the distance of the given point from the primitive is equal to the cosine of the given inclination.

Every thing remaining as in the preceding case; let A be the given point, and AC the cosine of an arch GV , equal to the given arch QP ; then drawing the diameter RCS at right angles to ACB , the ellipse described with the given axis RS, AB will be the projection of the inclined circle.

4. When the distance of the given point from the centre of the primitive is less than the semidiameter of the primitive, but greater than the cosine of the given inclination.

Let D be the given point, through which draw the diameter ICi ; and at the point D draw DL perpendicular to DC meeting the primitive in L ; also draw LK , making with LD the angle DLK equal to the complement of the given inclination. Let LK meet DC in K ; then will DK be less than DC . On DC as a diameter describe a circle, and make DH equal to DK ; through H draw a diameter of the primitive RCS , and describe an ellipse through the points R, D, S , and it will be the projection of the inclined circle.

Orthographic Projection of the Sphere.

PROPOSITION VIII. PROBLEM III.

Through two given points in the plane of the primitive to describe the projection of a great circle.

1. If the two given points and the centre of the primitive be in the same straight line, then a diameter of the primitive being drawn through these points will be the projection of the great circle required.

2. When the two given points are not in the same straight line with the centre of the primitive; and one of them is in the circumference of the primitive.

Plate ccccxii.

Let D, R, (fig. 34.) be the two given points, of which R is in the circumference of the primitive. Draw the diameter RCS, and GCg, FDH perpendicular to it, meeting the primitive in GgF. Divide GC, gC, in A, B, in the same proportion as FH is divided in D; and describe the ellipse whose axes are RS, AB, and centre C; and it will be the projection required.

3. When the given points are within the primitive, and not in the same straight line with its centre.

Let D, E (fig. 35.) be the two given points; through C the centre of the primitive draw the straight lines IDi, KEi; draw DL perpendicular to Ii, and EO perpendicular to Kk, meeting the primitive in L, O. Through E, and towards the same parts of C, draw EP parallel to DC, and in magnitude a fourth proportional to LD, DC, OE. Draw the diameter CP meeting the primitive in R, S, and describe an ellipse through the points D and R or S, and it will also pass through E. This ellipse will be the projection of the proposed inclined circle.

PROPOSITION IX. PROBLEM IV.

To describe the projection of a less circle parallel to the primitive, its distance from the pole of the primitive being given.

From the pole of the primitive, with the sine of the given distance of the circle from its pole, describe a circle, and it will be the projection of the given less circle.

PROPOSITION X. PROBLEM V.

About a given point as a projected pole to describe the projection of an inclined circle, whose distance from its pole is given.

Let P (fig. 36.) be the given projected pole, through which draw the diameter Gg, and draw the diameter Hh perpendicular thereto. From P draw PL perpendicular to GP meeting the circumference in L; through which draw the diameter Ll. Make LT, LK each equal to the chord of the distance of the less circle from its pole, and join TK, which intersects Ll in Q. From the points T, Q, K draw the lines FA, QS, KB, perpendicular to Gg; and make OR, OS, each equal to QT, or QK. Then an ellipse described through the points A, S, B, R will be the projection of the proposed less circle.

PROPOSITION XI. PROBLEM VI.

To find the poles of a given projected circle.

1. If the projected circle be parallel to the primitive, the centre of the primitive will be its pole.

Vol. XV. Part II.

2. If the circle be perpendicular to the primitive, then the extremities of a diameter of the primitive drawn at right angles to the straight line representing the projected circle, will be the poles of that circle.

3. When the projected circle is inclined to the primitive.

Let ARBS (fig. 36, 37.) be the elliptical projection of any oblique circle; through the centre of which, and C the centre of the primitive, draw the line of measures CBA, meeting the ellipse in B, A; and the primitive in G, g. Draw CH, BK, AT perpendicular to Gg, meeting the primitive in H, K, T. Bisect the arch KT in L, and draw LP perpendicular to Gg; then P will be the projected pole of the circle, of which ARBS is the projection.

PROPOSITION XII. PROBLEM VII.

To measure any portion of a projected circle, and conversely.

1. When the given projection is that of a great circle.

Let ADEB (fig. 38.) be the given great circle, either perpendicular or inclined to the primitive, of which the portion DE is to be measured, and let Mm be the line of measures of the given circle. Through the points D, E draw the lines EG, DF parallel to Mm; and the arch FG of the primitive will be the measure of the arch DE of the great circle, and conversely.

2. When the projection is that of a less circle parallel to the primitive.

Let DE (fig. 39.) be the portion to be measured, of the less circle DEH parallel to the primitive. From the centre C draw the lines CD, CE, and produce them to meet the primitive in the points B, F. Then the intercepted portion BF of the primitive will be the measure of the given arch DE of the less circle DEH.

3. If the given less circle, of which an arch is to be measured, is perpendicular to the primitive.

Let ADEB (fig. 40.) be the less circle, of which the measure of the arch DE is required. Through C, the centre of the primitive, draw the line of measures Mm, and from the intersection O of the given right circle, and the line of measures, with the radius OA, or OB, describe the semicircle AFGB; through the points D, E draw the lines DF, EG parallel to the line of measures, and the arch FG will be the measure of DE, to the radius AO. In order to find a similar arch in the circumference of the primitive, join OF, OG, and at the centre C of the primitive, make the angle mCH equal to FOG, and the arch mH to the radius Cm will be the measure of the arch DE.

4. When the given projection is of a less circle inclined to the primitive.

Let RDS (fig. 41.) be the projection of a less circle inclined to the primitive, and DE a portion of that circle to be measured. Through O the centre of the projected circle, and C the centre of the primitive, draw the line of measures Mm; and from the centre O, with the radius OR, or OS, describe the semicircle RGFS; through the points D, E draw the lines DF, EG parallel to the line of measures, and FG will be the measure of the arch DE to the radius OR, or OS. Join OF, OG, and make the angle mCH equal to FOG,

4 D

FOG,

Plate ccccxiii.

FOG, and the arch m II of the primitive will be the measure of the arch DE of the inclined circle RDS.

The converse of this proposition, namely, to cut off an arch from a given projected circle equal to a given arch of the primitive, is obvious.

The above operation would be greatly shortened by using the line of sines in the sector.

It seems unnecessary to insist farther on this projection, especially as the reader will see the application of it to the projection of the sphere on the planes of the *Meridian*, *Equator*, and *Horizon* in the article *GEOGRAPHY*; and to the delineation of *Eclipses* in the article *ASTRONOMY*. The *Analemma*, Plate CCXII. in the article *GEOGRAPHY*, is also according to this projection; and the method of applying it to the solution of astronomical problems is there exemplified.

SECTION III.

Of the Gnomonic Projection of the Sphere.

In this projection the eye is in the centre of the sphere, and the plane of projection touches the sphere in a given point parallel to a given circle. It is named *gnomonic*, on account of its being the foundation of dialling: the plane of projection may also represent the plane of a dial, whose centre being the projected pole, the semiaxis of the sphere will be the stile or gnomon of the dial.

As the projection of great circles are represented by straight lines, and less circles parallel to the plane of projection are projected into concentric circles; therefore many problems of the sphere are very easily resolved. Other problems, however, become more intricate on account of some of the circles being projected into ellipses, parabolas, and hyperbolas.

PROPOSITION I. THEOREM I.

Every great circle is projected into a straight line perpendicular to the line of measures; and whose distance from the centre is equal to the cotangent of its inclination, or to the tangent of its nearest distance from the pole of the projection.

Plate
ccccxii.

Let BAD (fig. 42.) be the given circle, and let the circle CBED be perpendicular to BAD, and to the plane of projection; whose intersection CF with this last plane will be the line of measures. Now since the circle CBED is perpendicular both to the given circle BAD and to the plane of projection, the common section of the two last planes produced will therefore be perpendicular to the plane of the circle CBED produced, and consequently to the line of measures: hence the given circle will be projected into that section; that is, into a straight line passing through d , perpendicular to Cd . Now Cd is the cotangent of the angle CdA , the inclination of the given circle, or the tangent of the arch CD to the radius AC.

COROLLARIES.

1. A great circle perpendicular to the plane of projection is projected into a straight line passing through the centre of projection; and any arch is projected into its correspondent tangent.

2. Any point, as D, or the pole of any circle, is

projected into a point d , whose distance from the pole of projection is equal to the tangent of that distance.

3. If two great circles be perpendicular to each other, and one of them passes through the pole of projection, they will be projected into two straight lines perpendicular to each other.

4. Hence if a great circle be perpendicular to several other great circles, and its representation pass through the centre of projection; then all these circles will be represented by lines parallel to one another, and perpendicular to the line of measures, for representation of that first circle.

PROPOSITION II. THEOREM II.

If two great circles intersect in the pole of projection, their representations will make an angle at the centre of the plane of projection, equal to the angle made by these circles on the sphere.

For since both these circles are perpendicular to the plane of projection, the angle made by their intersections with this plane is the same as the angle made by these circles.

PROPOSITION III. THEOREM III.

Any less circle parallel to the plane of projection is projected into a circle whose centre is the pole of projection, and its radius is equal to the tangent of the distance of the circle from the pole of projection.

Let the circle PI (fig. 42.) be parallel to the plane GF, then the equal arches PC, CI are projected into the equal tangents GC, CH; and therefore C, the point of contact and pole of the circle PI and of the projection, is the centre of the representation G, H.

COROLLARY.

If a circle be parallel to the plane of projection, and 45 degrees from the pole, it is projected into a circle equal to a great circle of the sphere; and therefore may be considered as the primitive circle, and its radius the radius of projection.

PROPOSITION IV. THEOREM IV.

A less circle not parallel to the plane of projection is projected into a conic section, whose transverse axis is in the line of measures; and the distance of its nearest vertex from the centre of the plane of projection is equal to the tangent of its nearest distance from the pole of projection; and the distance of the other vertex is equal to the tangent of the greatest distance.

Any less circle is the base of a cone whose vertex is at A (fig. 43.); and this cone being produced, its intersection with the plane of projection will be a conic section. Thus the cone DAF, having the circle DF for its base, being produced, will be cut by the plane of projection in an ellipse whose transverse diameter is df ; and Cd is the tangent of the angle CAD, and Cf the tangent of CAF. In like manner, the cone AFE, having the side AE parallel to the line of measures df , being cut by the plane of projection, the section will be a parabola, of which f is the nearest vertex,

Gnomonic
Projection
of the
Sphere.

tex, and the point into which E is projected is at an infinite distance. Also the cone AFG, whose base is the circle FG, being cut by the plane of projection, the section will be a hyperbola; of which f is the nearest vertex; and GA being produced gives d the other vertex.

COROLLARIES.

1. A less circle will be projected into an ellipse, a parabola, or hyperbola, according as the distance of its most remote point is less, equal to, or greater than, 90 degrees.

2. If H be the centre, and K, k , l the focus of the ellipse, hyperbola, or parabola; then $HK = \frac{Ad - Af}{2}$ for the ellipse; $Hk = \frac{Ad + Af}{2}$ for the hyperbola; and fn being drawn perpendicular to AE $fl = \frac{nE + Ff}{2}$ for the parabola.

PROPOSITION V. THEOREM V.

Plate
CCCCXXII.

Let the plane TW (fig. 44.) be perpendicular to the plane of projection TV, and BCD a great circle of the sphere in the plane TW. Let the great circle BED be projected into the straight line bek . Draw CQS perpendicular to bk , and Cm parallel to it and equal to CA, and make QS equal to Qm; then any angle QSt is the measure of the arch Qt of the projected circle.

Join AQ: then because Cm is equal to CA, the angle QCm equal to QCA, each being a right angle, and the side QC common to both triangles; therefore Qm, or its equal QS, is equal QA. Again, since the plane ACQ is perpendicular to the plane TV, and lQ to the intersection CQ; therefore bQ is perpendicular both to AQ and QS: hence, since AQ and QS are equal, all the angles at S cut the line bQ in the same points as the equal angles at A. But by the angles at A the circle BED is projected into the line bQ. Therefore the angles at S are the measures of the parts of the projected circle bQ; and S is the dividing centre thereof.

COROLLARIES.

1. Any great circle bQt is projected into a line of tangents to the radius SQ.

2. If the circle bC pass through the centre of projection, then the projecting point A is the dividing centre thereof, and Cb is the tangent of its correspondent arch CB to CA the radius of projection.

PROPOSITION VI. THEOREM VI.

Let the parallel circle GLH (fig. 44.) be as far from the pole of projection C as the circle FNI is from its pole; and let the distance of the poles C, P be bisected by the radius AO; and draw bAD perpendicular to AO; then any straight line bQt drawn through b will cut off the arches bl, Fn equal to each other in the representations of these equal circles in the plane of projection.

Let the projections of the less circles be described. Then, because BD is perpendicular to AO, the arches

BO, DO are equal; but since the less circles are equally distant each from its respective pole, therefore the arches FO, OH are equal; and hence the arch BF is equal to the arch DH. For the same reason the arches BN, DL are equal; and the angle FBN is equal to the angle LDH; therefore, on the sphere, the arches FN, HL are equal. And since the great circle BNLD is projected into the straight line bQn l, &c. therefore n is the projection of N, and l that of L; hence fn , bl , the projections of FN, HL respectively, are equal.

PROPOSITION VII. THEOREM VII.

If Fnk , blg (fig. 45.) be the projections of two equal circles, whereof one is as far from its pole P as the other from its pole C, which is the centre of projection; and if the distance of the projected poles C, p be divided in o, so that the degrees in Co, op be equal, and the perpendicular oS be erected to the line of measures gb . Then the line pn, Cl drawn from the poles C, p, through any point Q in the line oS, will cut off the arches Fn, bl equal to each other, and to the angle QCp.

The great circle AO perpendicular to the plane of the primitive is projected into the straight line oS perpendicular to gb , by Prop. i. Cor. 3. Let Q be the projection of q; and since pQ, CQ are straight lines, they are therefore the representations of the arches Pq, Cq of great circles. Now since PqC is an isosceles spherical triangle, the angles PCQ, CPQ are therefore equal; and hence the arches Pq, Cq produced will cut off equal arches from the given circles FI, GH, whose representations Fn, bl are therefore equal: and since the angle QCp is the measure of the arch bl, it is also the measure of its equal Fn.

COROLLARY.

Hence, if from the projected pole of any circle a perpendicular be erected to the line of measures, it will cut off a quadrant from the representation of that circle.

PROPOSITION VIII. THEOREM VIII.

Let Fnk (fig. 45.) be the projection of any circle FI, and p the projection of its pole P. If Cg be the cotangent of CAP, and gB perpendicular to the line of measures gc , let CAP be bisected by AO, and the line oB drawn to any point B, and also pB cutting Fnk in d; then the angle goB is the measure of the arch Fd.

The arch PG is a quadrant, and the angle goA = $gPA + oAP = gAC + oAP = gAC + CAo = gAo$; therefore $gA = go$; consequently o is the dividing centre of gB, the representation of GA; and hence, by Prop. v. the angle goB is the measure of gB. But since pg represents a quadrant, therefore p is the pole of gB; and hence the great circle pdB passing through the pole of the circles gB and Fn will cut off equal arches in both, that is, $Fd = gB = \text{angle } goB$.

COROLLARY.

The angle goB is the measure of the angle gpB.
4 D 2 For

Gnomonic
Projection
of the
Sphere.

For the triangle $g p B$ represents a triangle on the sphere, wherein the arch which $g B$ represents is equal to the angle which the angle p represents; because $g p$ is a quadrant; therefore $g o B$ is the measure of both.

PROPOSITION IX. PROBLEM I.

To draw a great circle through a given point, and whose distance from the pole of projection is equal to a given quantity.

Plate
ccccxxii.

Let ADB (fig. 46.) be the projection, C its pole or centre, and P the point through which a great circle is to be drawn: through the points P, C draw the straight line PCA , and draw CE perpendicular to it: make the angle CAE equal to the given distance of the circle from the pole of projection C ; and from the centre C , with the radius CE , describe the circle EFG : through P draw the straight line PIK , touching the circle EFG in I , and it will be the projection of the great circle required.

PROPOSITION X. PROBLEM II.

To draw a great circle perpendicular to a great circle which passes through the pole of projection, and at a given distance from that pole.

Let ADB (fig. 46.) be the primitive, and CI the given circle: draw CL perpendicular to CI , and make the angle CLI equal to the given distance: then the straight line KP , drawn through I parallel to CL , will be the required projection.

PROPOSITION XI. PROBLEM III.

At a given point in a projected great circle, to draw another great circle to make a given angle with the former; and, conversely, to measure the angle contained between two great circles.

Let P (fig. 47.) be the given point in the given great circle PB , and C the centre of the primitive: through the points P, C draw the straight line PCG ; and draw the radius of the primitive CA perpendicular thereto; join PA ; to which draw AG perpendicular: through G draw BGD at right angles to GP , meeting PB in B ; bisect the angle CAP by the straight line AO ; join BO , and make the angle BOD equal to that given; then DP being joined, the angle BPD will be that required.

If the measure of the angle BPD be required, from the points B, D draw the lines BO, DO , and the angle BOD is the measure of BPD .

PROPOSITION XII. PROBLEM IV.

To describe the projection of a less circle parallel to the plane of projection, and at a given distance from its pole.

Let ADB (fig. 46.) be the primitive, and C its centre: set the distance of the circle from its pole, from B to H , and from H to D ; and draw the straight line AED , intersecting CE perpendicular to BC , in the point E : with the radius CE describe the circle EFG , and it is the projection required.

PROPOSITION XIII. PROBLEM V.

To draw a less circle perpendicular to the plane of projection.

Let C (fig. 48.) be the centre of projection, and TI a great circle parallel to the proposed less circle: at C make the angles ICN, TCO each equal to the distance of the less circle from its parallel great circle TI : let CL be the radius of projection, and from the extremity L draw LM perpendicular thereto; make CV equal to LM ; or CF equal to CM : then with the vertex V and asymptotes CN, CO describe the hyperbola WVK ; or, with the focus F and CV describe the hyperbola, and it will be the perpendicular circle described.

Gnomonic
Projection
of the
Sphere.

Plate
ccccxxiii.

See Conic
Sections.

PROPOSITION XIV. PROBLEM VI.

To describe the projection of a less circle inclined to the plane of projection.

Draw the line of measures dp (fig. 49.) and at C , the centre of projection, draw CA perpendicular to dp , and equal to the radius of projection: with the centre A , and radius AC , describe the circle $DCFG$; and draw RAE parallel to dp : then take the greatest and least distances of the circle from the pole of projection, and set them from C to D and F respectively, for the circle DF ; and from A , the projecting point, draw the straight lines AFf , and ADd ; then df will be the transverse axis of the ellipse: but if D fall beyond the line RE , as at G , then from G draw the line $GADd$, and df is the transverse axis of an hyperbola: and if the point D fall in the line RE , as at E , then the line AE will not meet the line of measures, and the circle will be projected into a parabola whose vertex is f : bisect df in H , the centre, and for the ellipse take half the difference of the lines Ad, Af , which laid from H will give K the focus: for the hyperbola, half the sum of Ad, Af being laid from H , will give k its focus: then with the transverse axis df , and focus K , or k , describe the ellipse dMf , or hyperbola $f m$, which will be the projection of the inclined circle: for the parabola, make EQ equal to Ff , and draw fn perpendicular to AQ , and make fk equal to one half of nQ : then with the vertex f , and focus k , describe the parabola $f m$, for the projection of the given circle EE .

PROPOSITION XV. PROBLEM VII.

To find the pole of a given projected circle.

Let DMF (fig. 50.) be the given projected circle, whose line of measures is DF , and C the centre of projection: from C draw the radius of projection CA , perpendicular to the line of measures, and A will be the projecting point: join AD, AF , and bisect the angle DAF by the straight line AP ; hence P is the pole. If the given projection be an hyperbola, the angle fAG (fig. 49.), bisected, will give its pole in the line of measures; and in a parabola, the angle fAE bisected will give its pole.

PROPOSITION XVI. PROBLEM VIII.

To measure any portion of a projected great circle, or to lay off any number of degrees thereon.

Let EP (fig. 51.) be the great circle, and IP a portion thereof to be measured: draw ICD perpendicular to IP ; let C be the centre, and CB the radius of projection, with which describe the circle EBD ; make

Gnomonic
Projection
of the
Sphere.

IA equal to IB; then A is the dividing centre of EP; hence AP being joined, the angle IAP is the measure of the arch IP.

Or, if IAP be made equal to any given angle, then IP is the correspondent arch of the projection.

PROPOSITION XVII. PROBLEM IX.

To measure any arch of a projected less circle, or to lay off any number of degrees on a given projected less circle.

Plate

ccccxiii. Let F^n (fig. 52.) be the given less circle, and P its pole: from the centre of projection C draw CA perpendicular to the line of measures GH, and equal to the radius of projection; join AP, and bisect the angle CAP by the straight line AO, to which draw AD perpendicular: describe the circle G/H, as far distant from the pole of projection C as the given circle is from its pole P; and through any given point n , in the projected circle F^n , draw Dn , then Hl is the measure of the arch F^n .

Or let the measure be laid from H to l , and the line Dl joined will cut off F^n equal thereto.

PROPOSITION XVIII. PROBLEM X.

To describe the gnomonic projection of a spherical triangle, when three sides are given; and to find the measures of either of its angles.

Let ABC (fig. 53.) be a spherical triangle whose three sides are given: draw the radius CD (fig. 54.) perpendicular to the diameter of the primitive EF; and at the point D make the angles CDA, CDG, ADI, equal respectively to the sides AC, BC, AB, of the spherical triangle ABC (fig. 53.), the lines DA, DG intersecting the diameter EF, produced if necessary in the points A and G: make DI equal to DG; then from the centre C, with the radius CG, describe an arch; and from A, with the distance AI, describe another arch, intersecting the former in B; join AB, CB, and ACB will be the projection of the spherical triangle (fig. 53.); and the rectilineal angle ACB is the measure of the spherical angle ACB (fig. 53.).

PROPOSITION XIX. PROBLEM XI.

The three angles of a spherical triangle being given, to project it, and to find the measures of the sides.

Let ABC (fig. 55.) be the spherical triangle of which the angles are given: construct another spherical triangle EFG, whose sides are the supplements of the given angles of the triangle ABC; and with the sides of this supplemental triangle describe the gnomonic projection, &c. as before.

It may be observed, that the supplemental triangle EFG has also a supplemental part EFG ; and when the sides GE, GF, which are substituted in place of the angles A, B, are obtuse, their supplements gE , gF are to be used in the gnomonic projection of the triangle.

PROPOSITION XX. PROBLEM XII.

Given two sides, and the included angle of a spherical triangle, to describe the gnomonic projection of that triangle, and to find the measures of the other parts.

Let the sides AC, CB, and the angle ACB (fig. 53.), be given: make the angles CDA, CDG (fig. 56.) equal respectively to the sides AC, CB (fig. 53.); also make the angle ACB (fig. 56.) equal to the spherical angle ACB (fig. 53.), and CB equal to CG, and ABC will be the projection of the spherical triangle.

To find the measure of the side AB: from C draw CL perpendicular to AB, and CM parallel thereto, meeting the circumference of the primitive in M; make LN equal to LM; join AN, BN, and the angle ANB will be the measure of the side AB.

To find the measure of either of the spherical angles, as BAC: from D draw DK perpendicular to AD, and make KH equal to KD: from K draw KI perpendicular to CK, and let AB produced meet KI in I, and join HI: then the rectilineal angle KHI is the measure of the spherical angle BAC. By proceeding in a similar manner, the measure of the other angle will be found.

PROPOSITION XXI. PROBLEM XIII.

Two angles and the intermediate side given, to describe the gnomonic projection of the triangle; and to find the measures of the remaining parts.

Let the angles CAB, ACB, and the side AC of the spherical triangle ABC (fig. 53.), be given: make the angle CDA (fig. 56.) equal to the measure of the given side AC (fig. 53.); and the angle ACB (fig. 56.) equal to the angle ACB (fig. 53.); produce AC to H, draw DK perpendicular to AD, and make KH equal to KD; draw KI perpendicular to CK, and make the angle KHI equal to the spherical angle CAB: from I, the intersection of KI, HI, to A draw IA, and let it intersect CB in B, and ACB will be the gnomonic projection of the spherical triangle ABC (fig. 53.). The unknown parts of this triangle may be measured by last problem.

PROPOSITION XXII. PROBLEM XIV.

Two sides of a spherical triangle, and an angle opposite to one of them given, to describe the projection of the triangle; and to find the measure of the remaining parts.

Let the sides AC, CB, and the angle BAC of the spherical triangle ABC (fig. 53.) be given: make the angles CDA, CDG (fig. 56.) equal respectively to the measures of the given sides AC, BC: draw DK perpendicular to AD, make KH equal to DK, and the angle KHI equal to the given spherical angle BAC: draw the perpendicular KI, meeting HI in I; join AI; and from the centre C, with the distance CG, describe the arch GB, meeting AI in B, join CB, and ABC will be the rectilineal projection of the spherical triangle ABC (fig. 53.) and the measures of the unknown parts of the triangle may be found as before.

PROPOSITION XXIII. PROBLEM XV.

Given two angles, and a side opposite to one of them, to describe the gnomonic projection of the triangle, and to find the measures of the other parts.

Let the angles A, B, and the side BC of the triangle

Gnomonic
Projection
of the
Sphere.

Plate
CCCLXXIII.

angle ABC (fig. 55.), be given: let the supplemental triangle EFE be formed, in which the angles E, F, G, are the supplements of the sides BC, CA, AB respectively, and the sides EF, FG, GE, the supplements of the angles C, A, B. Now, at the centre C (fig. 56.) make the angles CDA, CDK equal to the measures of the sides GE, GF respectively, being the supplements of the angles B and A; and let the lines DA, DK intersect the diameter of the primitive EF, in the points A and K: draw DG perpendicular to AD, make GH equal to DG, and at the point H make the angle GHI equal to the angle E, or to its supplement; and let EI, perpendicular to CH, meet HI in I, and join AI: then from the centre C, with the distance CG, describe an arch intersecting AI in B; join CB, and ABC will be the gnomonic projection of the given triangle ABC (fig. 55.): the supplement of the angle ACB (fig. 56.) is the measure of the side AB, (fig. 55.); the measures of the other parts are found as before.

It has already been observed, that this method of projection has, for the most part, been applied to dialling only. However, from the preceding propositions, it appears that all the common problems of the sphere may be more easily resolved by this than by either of the preceding methods of projection; and the facility with which these problems are resolved by this method has given it the preference in dialling. It may not perhaps be amiss, in this place, to give a brief illustration of it in this particular branch of science.

In an horizontal dial, the centre of projection Z (fig. 57.) represents the zenith of the place for which the dial is to be constructed; ZA the perpendicular height of the style: the angle ZPA, equal to the given latitude, determines the distance ZP of the zenith from the pole; and AP the edge of the style, which by its shadow gives the hour: the angle ZAP, equal also to the latitude, gives the distance of the equator EQ from the zenith: let Ea be equal to EA, and a will be the dividing point of the equator. Hence if the angles Ea I, Ea II, &c. Ea XI, Ea X, &c. be made equal to 15°, 30°, &c. the equator will be divided into hours; and lines drawn from P to these points of division will be hour lines.

If the dial is either vertical, or inclined to the horizon, then the point Z will be the zenith of that place whose horizon is parallel to the plane of the dial: ZE

will be the latitude of that place; and the hours on the former dial will now be changed into others, by a quantity equal to the difference of longitude between the given place and that for which the dial is to be constructed. Thus if it is noon when the shadow of the style falls on the line PX, then the difference of meridians is the angle EaX, or 30°. Hence, when a dial is to be constructed upon a given plane, either perpendicular or inclined to the horizon, the declination and inclination of that plane must be previously found.

In an erect direct south dial, its zenith Z is the fourth point of the horizon, ZP is the distance of this point from the pole, and ZE its distance from the equator. If the dial is directed to the north, Z represents the north point of the horizon; PZ the distance of Z from the pole under the horizon; and ZE the elevation of the equator above the horizon.

If the dial is an erect east or west dial, the zenith Z is the east or west points of the horizon accordingly, and the pole P is at an infinite distance, for the angle ZAP is a right angle; and therefore the line AP will not meet the meridian PZ. The line ZA produced is the equator, and is divided into hours by lines perpendicular to it.

If the plane of the dial is parallel to the equator, its zenith Z coincides with one of the poles of the equator P; and hence the hour lines of this dial are formed by drawing lines from the point Z, containing angles equal to 15°.

In the preceding methods of projection of the sphere, equal portions of a great circle on the sphere are represented by unequal portions in the plane of projection, and this inequality increases with the distance from the centre of projection. Hence, in projections of the earth, those places towards the circumference of the projection are very much distorted. In order to avoid this inconveniency, M. de la Hire * proposed, that the eye should be placed in the axis produced at the distance of the sine of 45° beyond the pole: In this case arches of the sphere and their projections are very nearly proportional to each other. Hence in a map of the earth agreeable to this construction, the axis, instead of being divided into a line of semitangents, is divided equally, in like manner as the circumference. The map of the world, Plate CCXIV. is constructed agreeable to this method of projection.

* Hist. de
l'Académie
R. des Sciences
1701.
See also
article Geo-
graphy,
p. 639.

P R O

Projection.

PROJECTION, in perspective, denotes the appearance, or representation of an object on the perspective plane.

The projection, *e. gr.* of a point, as B (Fig. 1. Plate CCCLXXXIII.) is a point *b*, through which the optic ray BE passes from the objective point through the plane to the eye; or it is the point wherein the plane cuts the optic ray.

And hence is easily conceived what is meant by the projection of a line, a plane, or a solid.

PROJECTION in Alchemy, the casting of a certain imaginary powder, called *powder of projection*, into a crucible, or other vessel, full of some prepared metal, or

P R O

other matter; which is to be hereby presently transmuted into gold.

Powder of PROJECTION, or of the philosophers stone, is a powder supposed to have the virtue of changing any quantity of an imperfect metal, as copper or lead, into a more perfect one, as silver or gold, by the admixture of a little quantity thereof.

The mark to which alchemists direct all their endeavours, is to find the powder of projection; which every one of them has been within an ace of a hundred times. See *PHILOSOPHER'S Stone*.

PROJECTURE, in architecture, the outjetting and prominency, or embossing, which the mouldings

Projection,
Projecture.

Prolapsus and other members have beyond the naked wall, column, &c.

Prolific.

PROLAPSUS, in surgery, a prolapsion or falling out of any part of the body from its natural situation: thus we say, *prolapsus intestini*, "a prolapsion of the intestine," &c. See **SURGERY**.

PROLATE, in geometry, an epithet applied to a spheroid produced by the revolution of a semi-ellipsis about its larger diameter. See **SPHEROID**.

PROLEGOMENA, in philology, certain preparatory observations or discourses prefixed to a book, &c. containing something necessary for the reader to be apprised of, to enable him the better to understand the book, or to enter deeper into the science, &c.

PROLEPSIS, a figure in rhetoric, by which we anticipate or prevent what might be objected by the adversary. See **ORATORY**, n 80.

PROLEPTIC, an epithet applied to a periodical disease which anticipates, or whose paroxysm returns sooner and sooner every time; as is frequently the case in agues.

PROLIFER FLOS; (*proles*, "an offspring;" and *fero*, "to bear"); a prolific flower, or a flower which from its own substance produces another; a singular degree of luxuriance, to which full flowers are chiefly incident. See **BOTANY**, p. 428.

PROLIFIC, something that has the qualities necessary for generating.

The prolific powers of some individuals among mankind are very extraordinary.—Instances have been found where children, to the number of six, seven, eight, nine, and sometimes sixteen, have been brought forth after one pregnancy. The wife of Emmanuel Gago, a labourer near Valladolid, was delivered, the 14th of June 1779, of five girls, the two first of whom were baptized: the other three were born in an hour after; two of them were baptized; but the last, when it came into the world, had every appearance of death. The celebrated Tarfin was brought to bed in the seventh month of her pregnancy, at Argenteuil near Paris, 17th July 1779, of three boys, each 14 inches and a half long, and of a girl 13 inches: they were all four baptized, but did not live 24 hours.

The public papers for the month of June 1779 made mention of one Maria Ruiz, of the district of Lucena in Andalusia, who was successively delivered of 16 boys, without any girls; and seven of them were still alive on the 17th of August thereafter. The following, though a recent fact, is almost incredible: In the year 1755, a Muscovite peasant, named *James Kyrloff*, and his wife, were presented to the Empress of Russia. This peasant had been twice married, and was then 70 years of age. His first wife was brought to bed 21 times; namely, four times of four children each time; seven times of three, and ten times of two; making in all 57 children, who were then alive. His second wife, who accompanied him, had already been delivered seven times, once of three children, and six times of twins, which made 15 children for her share. Thus the Muscovite patriarch had already had 72 children by two marriages. We are assured that the sultan Mustapha III. had issue by his concubines 580 male children. What number of female children he had, and whether there were twins of both sexes, we are not informed. These facts suppose great fecundity;

and whatever credit is given to them, we must consider as entirely fabulous what is reported concerning a countess of Holland who was delivered of 365 children, of a very small size.

PROLIXITY, in discourse, the fault of entering into too minute a detail, or being too long, precise, and circumstantial, even to a degree of tediousness.

PROLOCUTOR of the convocation, the speaker or chairman of that assembly. See **CONVOCATION**.

PROLOGUE, in dramatic poetry, a discourse addressed to the audience before the drama or play begins. The original intention was to advertise the audience of the subject of the piece, and to prepare them to enter more easily into the action, and sometimes to make an apology for the poet.

PROMETHEUS, the son of Japetus, supposed to have been the first discoverer of the art of striking fire by flint and steel; which gave rise to the fable of his stealing fire from heaven: A renowned warrior; but whose history is involved in fable. He flourished about 1687 B. C. The poetical account is, that he formed a man of clay of such exquisite workmanship, that Pallas, charmed with his ingenuity, offered him whatever in heaven could contribute to finish his design; and for this purpose took him up with her to the celestial mansions, where he stole some fire from the chariot of the sun, which he used to animate his image. At this theft Jupiter was so enraged, that he ordered Vulcan to chain him down on Mount Caucasus, and sent an eagle or vulture to prey on his liver; which every night was renewed, in proportion to the quantity eaten up in the day-time, until at last he was delivered by Hercules, who killed the vulture.

PROMETHEUS, in ancient astronomy, was the name of a constellation of the northern hemisphere, now called *Hercules*, *Enconasin*. See **ASTRONOMY**, n 406.

PROMISE, in ordinary cases, is a declaration of some intention to be put in execution; but in morals is a solemn asseveration by which one pledges his veracity that he shall perform, or cause to be performed, the thing which he mentions.

As such a declaration excites expectations in the minds of those to whom it is made; and as to frustrate these expectations might rouse indignation, and be followed by consequences injurious to the person, the character, or interest, of him who made it—it becomes a matter of prudence in the promiser to keep his word. And farther, as a certain degree of confidence is found necessary to the very existence of civil society, and as others may have acted on the faith of his promise, it is now not a matter of prudence only to keep his word—it is a duty which he owes to all who have spent their time, their money, or their labour, in consequence of those expectations which he has warranted them to entertain.

It, then, being consonant to sound reason, necessary to the existence of civil society, and in general the interest of both the promiser and promisee, that the words of the promise should be fulfilled, it has become a maxim in morals that a man is obliged to perform his promise.

In many instances, the great difficulty concerning a promise is, how to explain it; for although the grounds of its obligation be those expectations which it has raised, a question will occur, Is the promiser bound to answer

Prolixity

Promise.

Promise

defined.

How it

comes to
be binding.

Interpretation

of a
promise
sometimes
difficult.
answer

Promise. answer fully all the expectations to which the different constructions of his words may have given birth? Should I, for instance, desire a man to run with a letter to such a place, and engage to satisfy him upon his return; and if on his return I gave him double of the usual hire in like cases; but if he be not satisfied with less than the triple of such a sum, am I obliged to grant his demands? This will lead us to consider the rules by which a promise should be interpreted.

4 Whether the meaning of the promiser or promisee ought to be taken. If a promise were always to be deemed obligatory in the sense in which the promisee receives it, a man would not know what he had promised; the promisee, from a difference of views, associations, and interests, might conceive a sense of which the promiser had never dreamed; might suppose engagements which were never intended, which could not be foreseen, and, although foreseen, could not be performed. For these reasons it is natural to think that the sense of the promiser should rather direct the interpretation. He knows precisely what it is he has undertaken, and is unquestionably the best judge of what meaning he affixed to his words. His explanation should therefore be admitted, if information alone could give him a title to decide in the affair.

But something more than mere information, or a knowledge of the cause, is expected from a judge, as integrity is equally essential to his character. Doubts may arise when the words will admit of various meanings, whether the promiser will be so candid as impartially to own the precise meaning which he had actually annexed to his expressions: At any rate, if he wished to deceive, he might purposely use an ambiguous phraseology, and perform the promise in a sense of his own without satisfying the reasonable hopes of the promisee.

When the daughter of Tarpeius bargained with Tatius to betray the citadel for what he and his Sabines wore on their left hands, meaning their rings and their golden bracelets, Tatius probably performed his promise in the way which he intended, when he caused her to be buried under their shields, which they carried also on their left hands. But who will say that here was not treachery and a dishonourable abuse of that confidence which had been reposed in him?

5 In doubtful cases the interpretation of neither is to be trusted. It must therefore be obvious, that the import of a promise, where its meaning is disputed, is not to be determined by the sense of the promiser nor by the expectations of the promisee; and if it was said that the obligation of a promise arose from those expectations which had been raised by it, the assertion now must be limited to those expectations which were intentionally raised by the promiser, or those which to his knowledge the promisee was induced to entertain in consequence of that declaration which had been made to him. Should there still be a doubt about what expectations were intentionally raised, and what should have been reasonably entertained, recourse must be had to the judgment of those who are allowed to be persons of candour, and who are acquainted with the characters of the men, and with those circumstances in which the promise was made.

6 Cases where a promise is not binding. The following are some of the cases in which a promise is not binding. As the obligation to perform the promise arises from those expectations which are intentionally raised by the promiser; it is plain that no promise can be binding before acceptance, before the promise has been communicated to the promisee, and be-

fore he has entertained hopes of its performance. The case is similar where a promise is released, that is, where the performance is dispensed with by the promisee, and where he entertains no expectations on account of any thing that the promiser has said to him. Should a third person entertain hopes on account of the promise, he is to cherish these hopes at his own hazard, having no encouragement from the promiser to do so: yet if this person has been warranted to hope by the promisee, the promisee has renounced his privilege of releasing the promise, and along with the promiser becomes bound for its performance.

A promise is not binding where the performance is unlawful; and the performance is unlawful where it is contrary to former promises, or to any moral and religious precept, which from the beginning to the end of time is of perpetual and unalterable obligation. Thus no man is bound by his promise to give to me what he has already promised to another; and no man is bound by his promise to blaspheme God, to commit murder, or to criminate the innocent. Such promises are unlawfully made, and cannot be otherwise than unlawfully performed.

Some have even carried their scruples so far as to doubt, whether any promise, unlawfully made, can be lawfully performed. Should a man, during the lifetime of his wife, happen to promise marriage to another, such a man (they say) by the Christian religion has already committed adultery in his heart; and should he afterwards become a widower, he is not bound, and he even ought not, to fulfil his engagements, as this would be putting his criminal intention into execution. This species of reasoning, we must confess, is to us unintelligible. — As the wife is dead, what now should prevent the man from marrying the object of his affections? Why, say the casuists, he already is under a promise to marry her, and his promise was made at a time when it should not have been made. It is true, the performance, considered by itself, is opposed by no law human or divine; but then it originated in what was wrong; and however much the Supreme Being and the bulk of the creation may be out of the secret, we have discovered by the ingenious logic of casuistry, that evil can never spring out of good, nor good out of evil; but that the means and the end, the motive and the action are always of the same complexion in morals.

When a promise is made, the particular circumstances in which it is to be deemed obligatory are sometimes mentioned. “I promise (for instance) to lend my friend 200 pounds within three days, provided a certain creditor which I name do not make a demand on me before that time. In other cases no circumstance is foreseen by the promiser to prevent the fulfilling of his engagement; and hence we have erroneous promises, which proceed on the supposition that things are true, possible, and lawful, which are not so. An erroneous promise, which proceeds on the false representation of the promisee, is not binding.

A London gentleman lately purchased an estate in the south of England at a public sale, believing the description which he saw in the newspapers, and which likewise was given by the auctioneer, to be true; but finding afterwards that the estate nowise corresponded to the description, the law freed him from his engagement, because the seller had evidently been guilty of

7 When it is released by the promiser.

8 Where its performance is unlawful.

9 A case where doubts have arisen.

10 Erroneous promises.

Fig. 1.

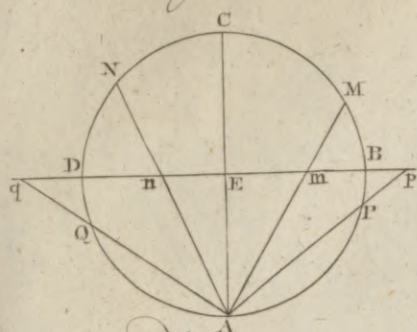


Fig. 2.

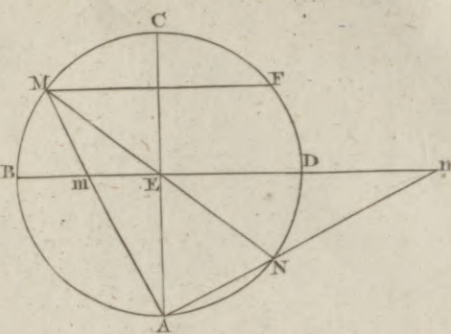
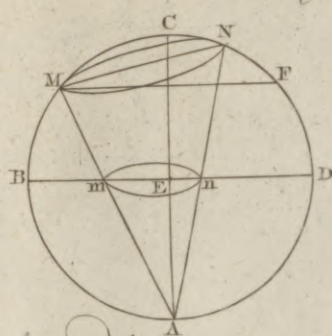


Fig. 3.

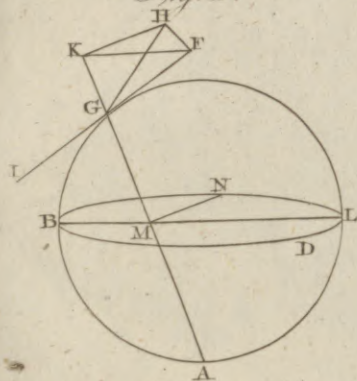


Fig. 4.

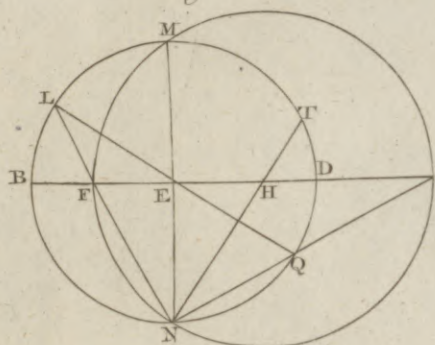


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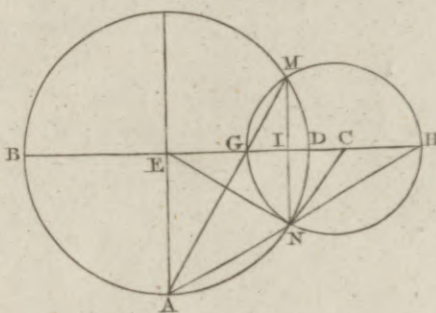


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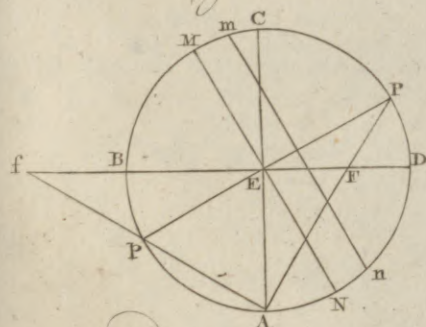


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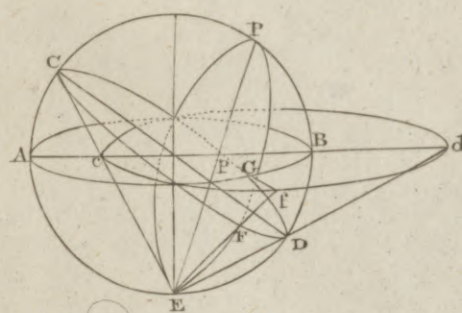


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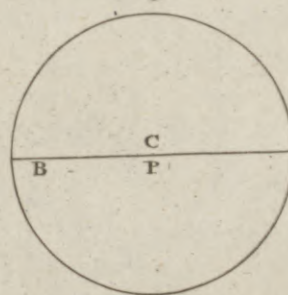


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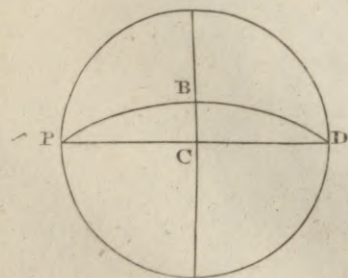


Fig. 10.

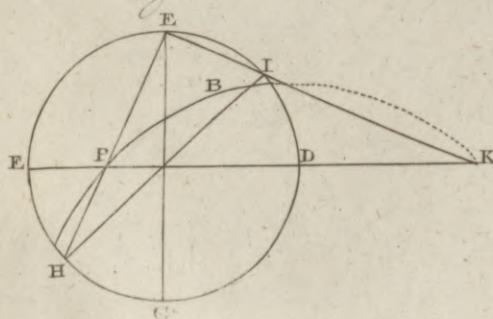
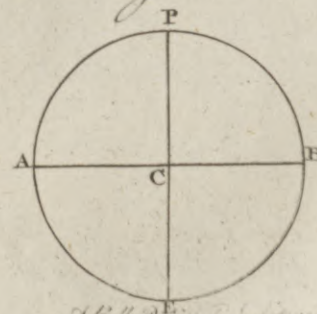


Fig. 11.



U. Bell Pin...

Fig. 12.

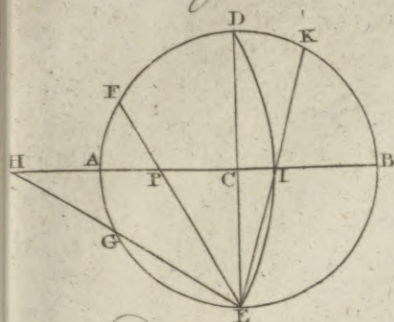


Fig. 13.

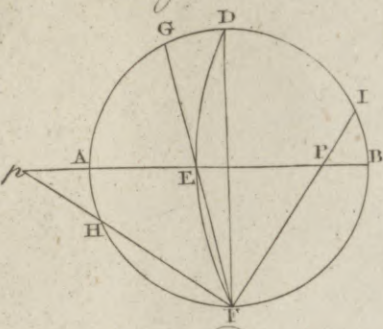


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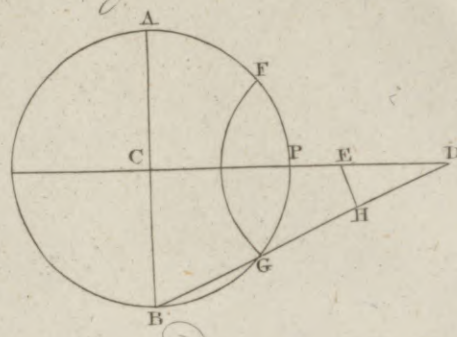


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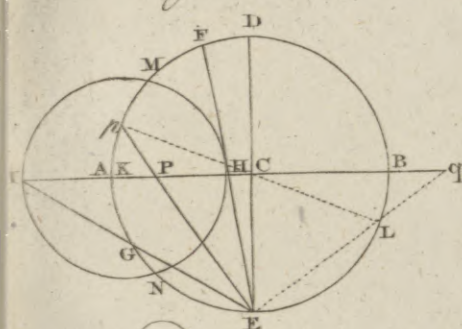


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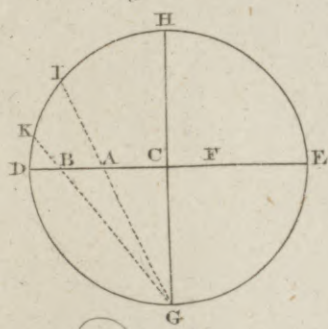
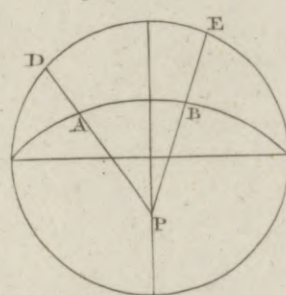


Fig. 17.



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Fig. 18.

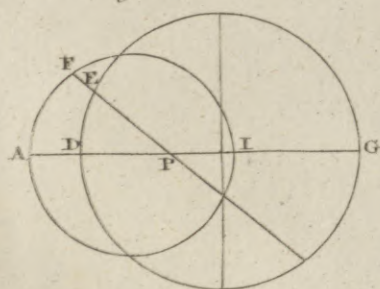


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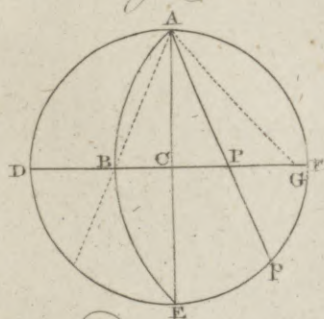


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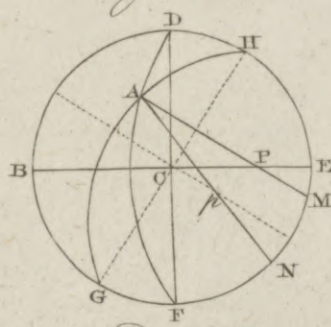
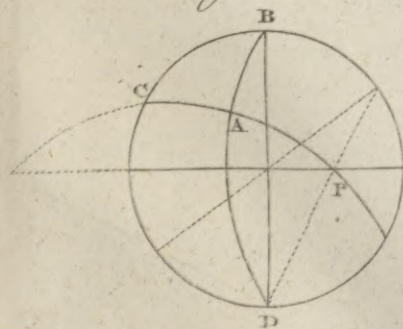


Fig. 21.



E
Fig. 22.

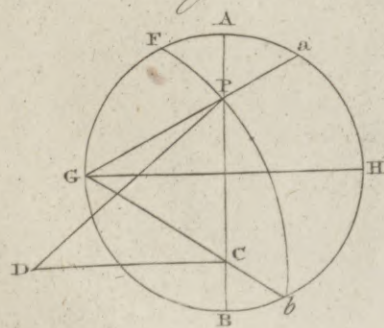
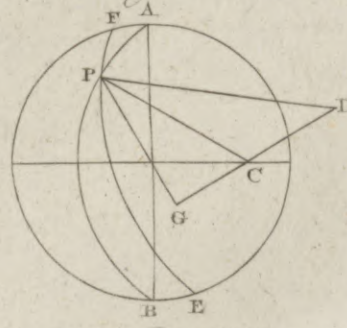
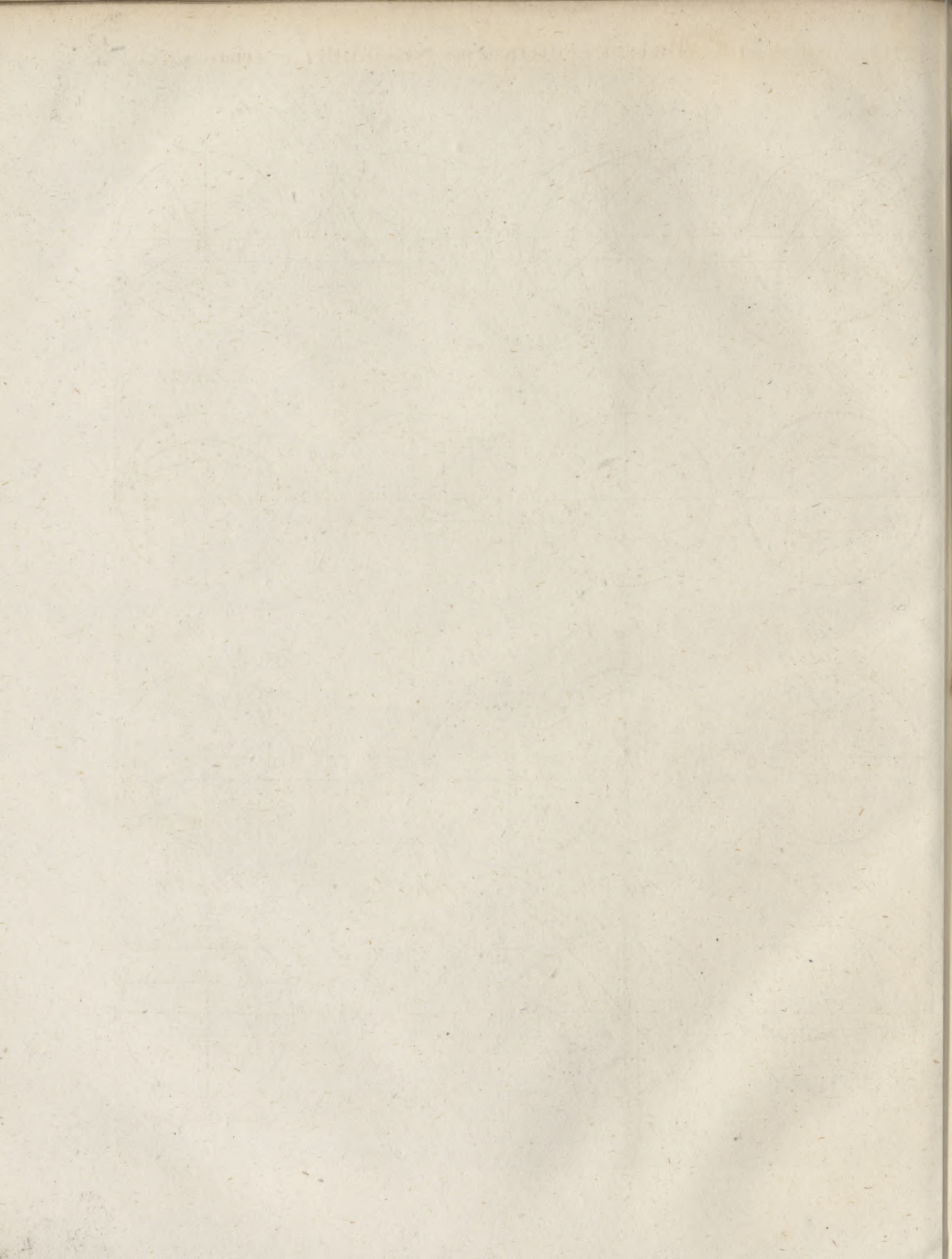
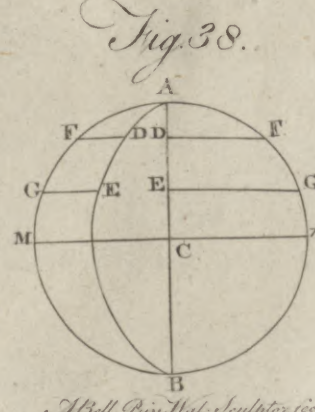
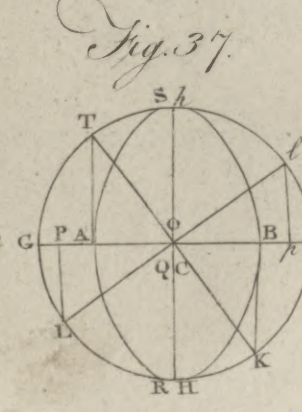
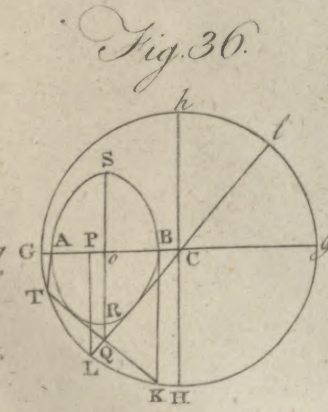
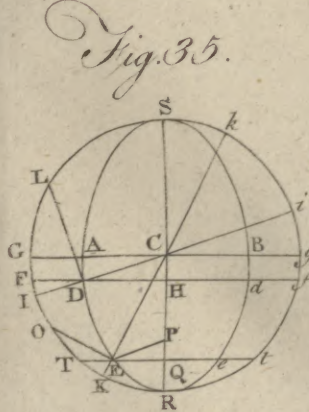
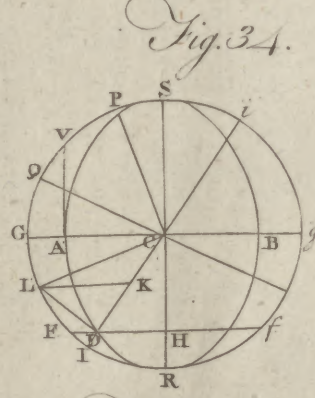
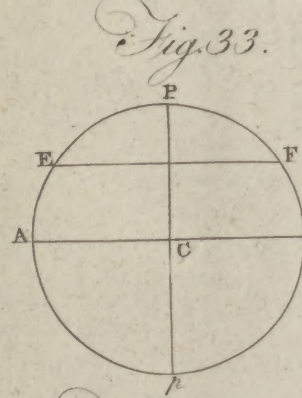
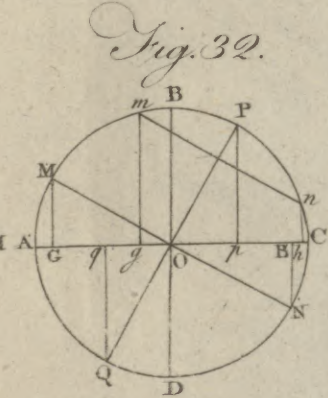
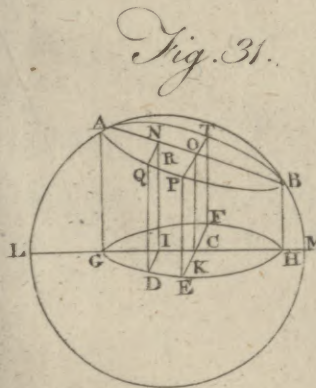
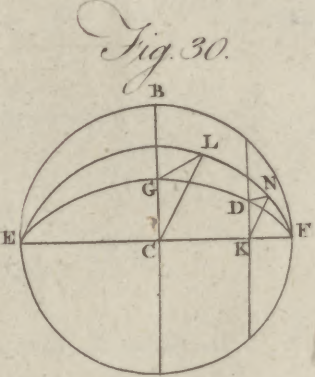
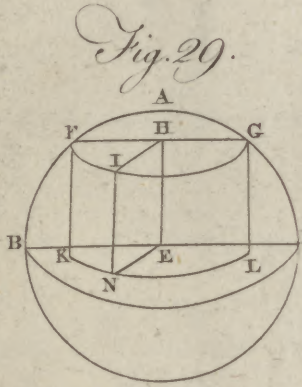
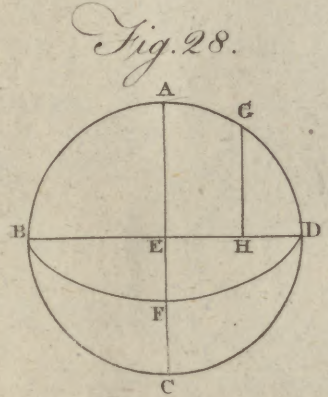
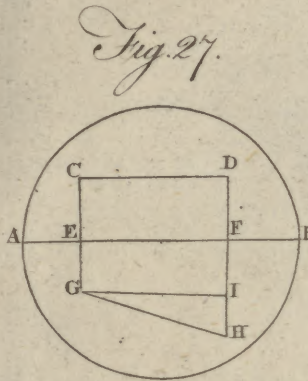
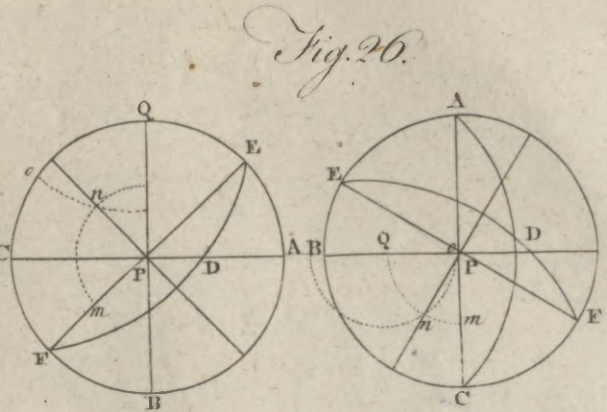
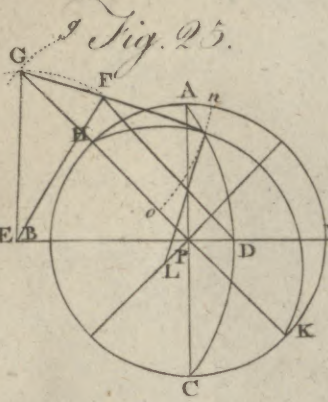
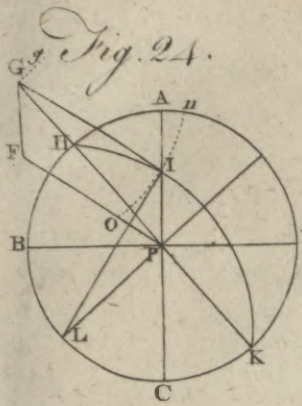


Fig. 23.



A. Bell Prin. Mat. Sculptor fecit.





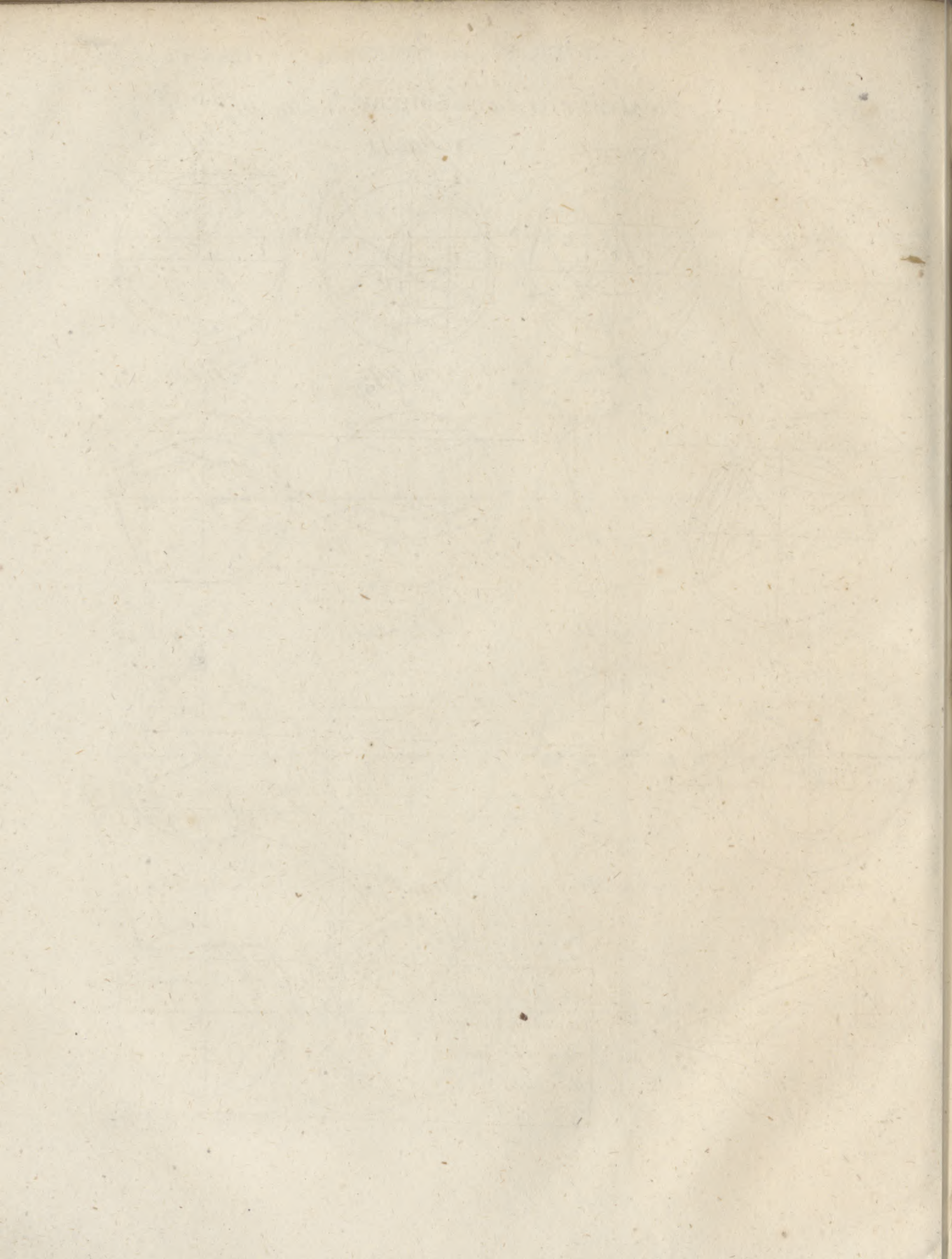


Fig. 39.

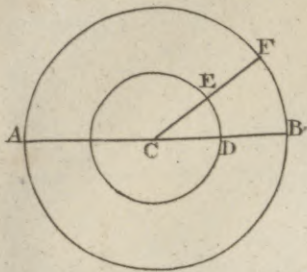


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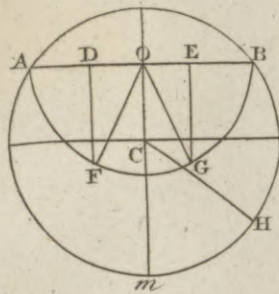


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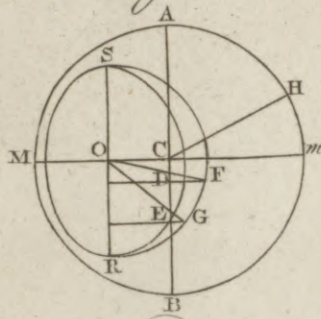


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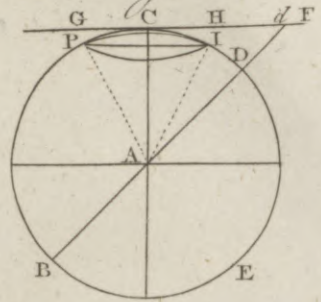


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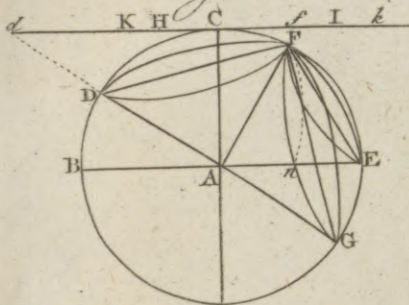


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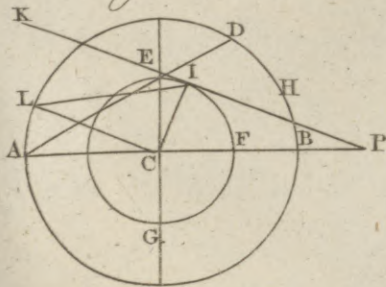


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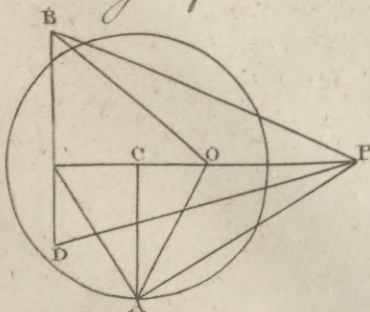


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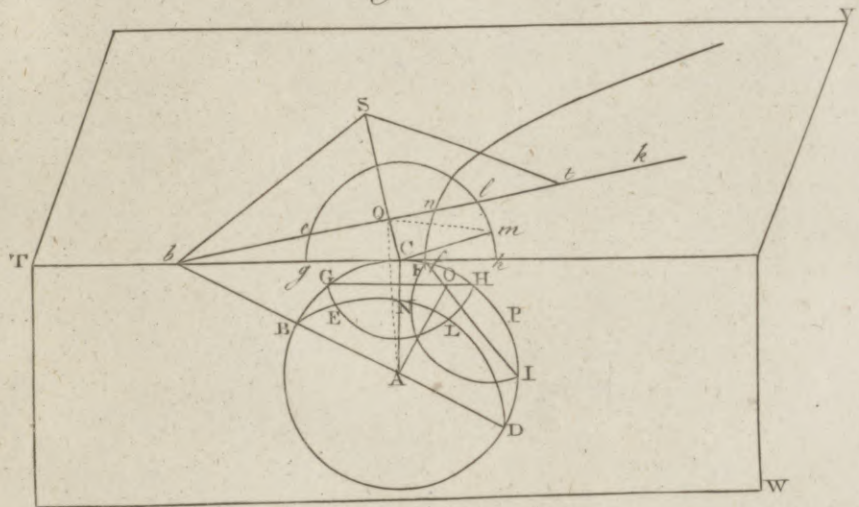
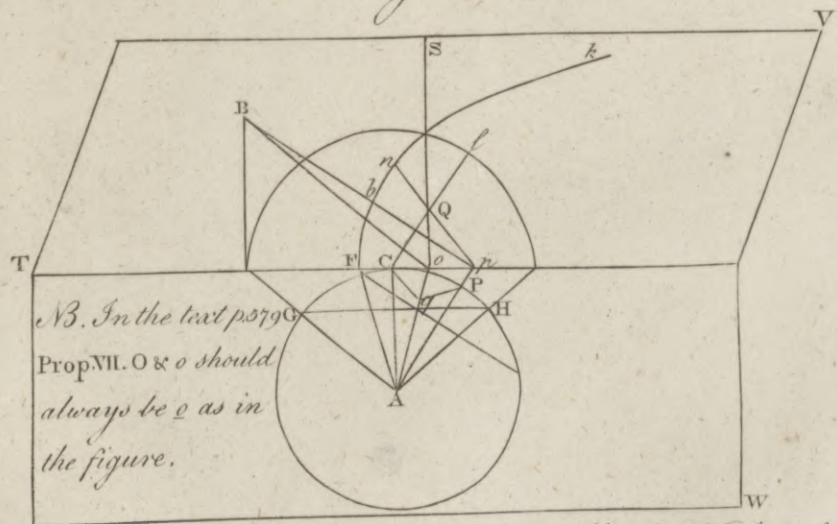


Fig. 45.



*NB. In the text p. 379
Prop. VII. O & o should
always be e as in
the figure.*

Fig. 48.

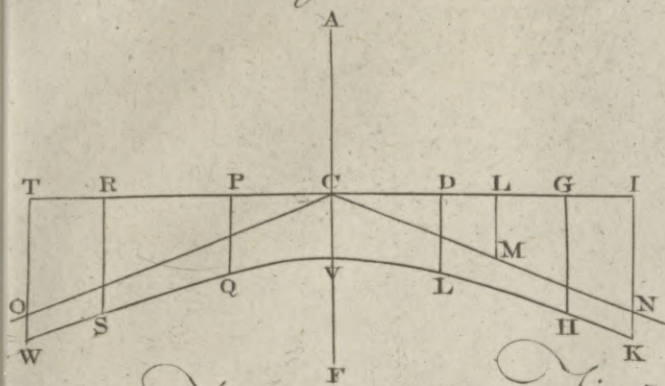


Fig. 49.

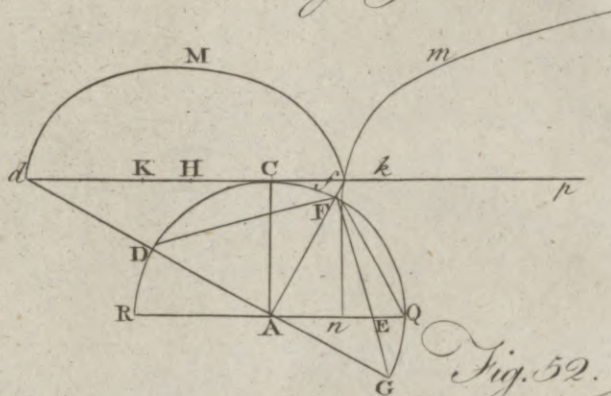


Fig. 50.

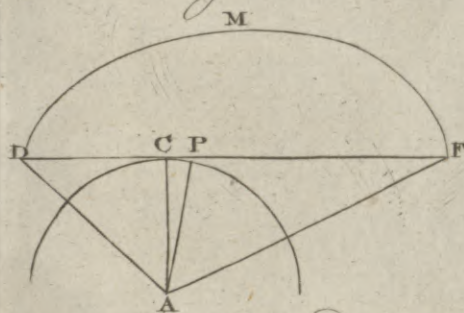


Fig. 51.

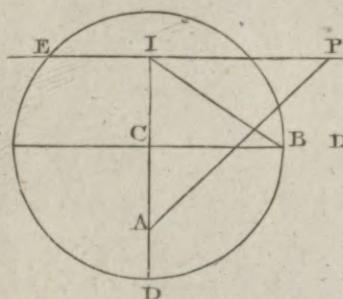


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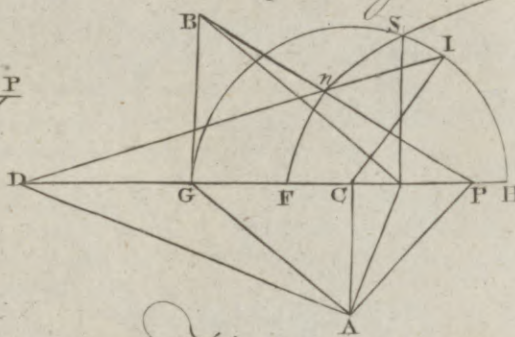


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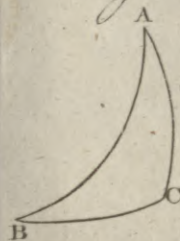


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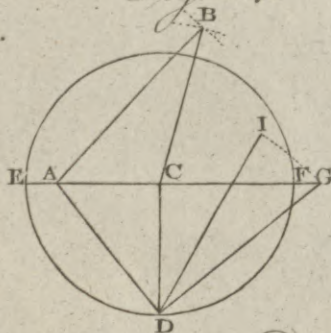


Fig. 55.

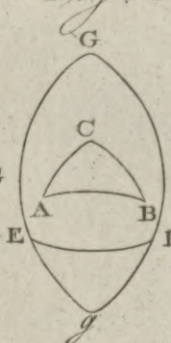


Fig. 56.

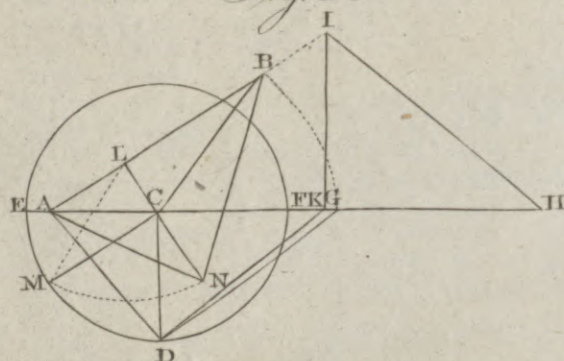
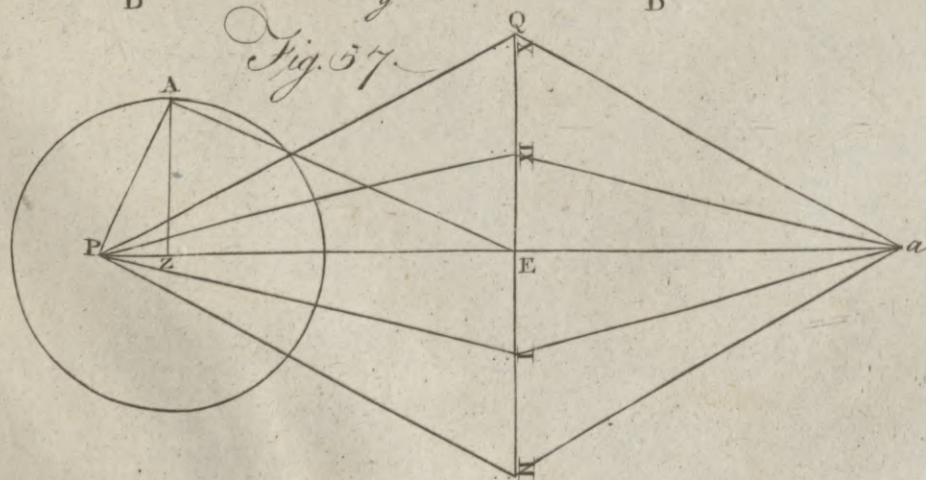


Fig. 57.



Promise. a breach of promise in not satisfying those expectations which he had intentionally and even studiously excited in the buyers.

11 A promise not binding when the performance is impossible, An erroneous promise, whose performance is impossible, is not binding. Before the conclusion of the late war a planter of Tobago promised to send to his friend in England 12 hogsheds of sugar from the next year's produce of his estate; but before that time Tobago fell into the hands of the French, and the West Indian found it impossible to answer the expectations of his friend in England.

12 Nor when it is unlawful. An erroneous promise, whose performance is unlawful, or, to speak more precisely, whose performance is contrary to a prior promise, or to any moral or religious obligation, is not binding. A father believing the accounts from abroad of his son's death, soon after bequeathes his fortune to his nephew: but the son, the report of whose death had been false, returns home, and the father is released from the promise to his nephew, because it was contrary to a prior promise, which he had tacitly come under to his son. This prior promise was implied in the whole of the father's conduct, and was expressed in signs as emphatic and as unequivocal as those of language. It had all the effect too of the most solemn promise on the son, who, to his father's knowledge, was induced in consequence of this promise to entertain the most sanguine hopes of succeeding to his father, if he survived. The world likewise could bear testimony that these expectations were not rashly cherished. He was brought into existence by means of his father, who was thereby understood to love him affectionately; he was ushered into society as the representative of his family, and was therefore supposed to be the heir of its wealth. Religion itself supported his pretensions, pronouncing the father worse than an infidel who neglects to show that attention to his children which the world naturally expects from a parent.—That the father's promise was not released from the mere circumstance that the mistake was known to his nephew the promisee, will appear plain from the following circumstance. Suppose the father a landed proprietor, that the lease of one of his farms has expired, and that he has long been expecting to let it at L. 200; suppose that this sum is refused, and that he agrees with the present tenant to grant a new lease at L. 150—the obligation here to perform his promise is not dissolved by an after offer of L. 200, though the tenant knew that L. 200 had been expected, and that only from despairing of that sum his landlord had granted the new lease at L. 150: the promise is binding, because the performance is every way lawful, contrary to no prior engagement, and opposed to no principle in morals. The law of the land, were the proprietor reluctant, would enforce the obligation, and exact obedience in the tone of authority; because breaches of faith, were they permitted in such cases, would destroy all confidence, and annihilate the bonds of social union:

Men live and prosper but in mutual trust;
A confidence of one another's truth. *Oroonoko.*

13 Utility no criterion whereby to judge of the validity of promises. The great difficulty which many have to encounter in determining when erroneous promises ought or ought not to be kept, arises from their proceeding on a principle of whose consequences they do not seem to be altogether aware.

Promise. There is seldom, they perceive, a virtuous action that is not attended with some happy effects; and it will, perhaps, be generally allowed, that the comparative merit of similar virtues may safely be estimated by their utility: But to make utility, as some do, the criterion of virtue, and pronounce an action vicious or virtuous merely on account of those consequences which they see may flow from it, is a dangerous maxim. Evil has often sprung out of good, and good out of evil; and good and evil have frequently sprung from the same action. In Mandeville's *Hive*,

That root of evil Avarice,
That damn'd ill-natur'd baneful vice,
Was slave to Prodigality,
That noble sin; whilst Luxury
Employ'd a million of the poor,
And odious Pride a million more.
Envy itself and Vanity
Were ministers of Industry:
That darling folly, Fickleness,
In diet, furniture, and dress,
That strange ridiculous vice, was made
The very wheel that turn'd the trade.

14 This principle would give a sanction to vice and falsehood.

The description here is not altogether false; and these indeed may be some of the consequences that flow from avarice, luxury, pride, vanity, and envy: but these are not all.—To see at once all the consequences that spring from an action, the good and the bad, the particular and general, the immediate and remote, would require sometimes the foresight of Omniscience, and at all times a knowledge superior to what is human. In the Fable of the Bees, the author's object was to show that private vices are public benefits; and he therefore was naturally led by his argument to consider only such consequences of vice as favoured his hypothesis. He wanted candour. And that artifice which runs through his Fable happens to remind us, that while the remote and the general effects of an action may not be seen, the particular and immediate, which fall within our notice, are apt to be viewed through the medium of passion, interest, or opinion. For these reasons, it appears surprising how any person should ever imagine that the obligation to perform a promise should depend entirely upon the ideas which the promiser apprehended of its utility.

The best refutation of such an opinion are the singular conclusions to which it leads.

15 A late writer on political justice, who appears to have embraced it, gets into reasoning not very common. In a part of his system he looks on morals as an article of trade: virtue and vice, in his Chapter of *Promises*, are but antiquated terms for profit and loss; and right and wrong are used to express what is beneficial and what is hurtful, in his apprehension, to himself and the community.—With respect to veracity, those “rational and intelligent beings,” by whom he wishes the affairs of the world to be carried on, may, while they act as rational and intelligent, break or perform their promises at pleasure. He thinks it “essential to various circumstances of human intercourse, that we should be known to bestow a steady attention upon the quantities of convenience or inconvenience, of good or evil, that might arise to others from our conduct.” After this attention, the disappointment of the promisee is not to be minded,

Promise. minded, though the expectations excited by these "rational and intelligent beings" may have "altered the nature of his situation, and engaged him in undertakings from which he would otherwise have abstained." What the promiser takes to be the general utility and the fitness of things is to be his guide. And a breach of promise will be attended with the following advantages: "The promisee, and all other men, will be taught to depend more upon their own exertions, and less upon the assistance of others, which caprice may refuse or justice withhold. He and all others will be taught to acquire such merit, and to engage in such pursuits, as shall oblige any honest man to come to their succour if they should stand in need of assistance." This breach of promise, with a view to the general utility, will, so far from being criminal, form a part of that resolute execution of justice which would in a thousand ways increase the independence, the energies, and the virtue of mankind*."

* Godwin's Inquiry concerning Political Justice, book 3. ch. 3.

16
A private individual has no right to intrude his schemes of utility on the public

* See Note, the celebrated Turgot*, that romances are the only books in which moral principles are treated in an impartial manner, this gentleman, in his Chapter of Promises, seems to have borrowed a part of his morality from the doggerels of Butler; and having adopted, though from different motives, the political principles of Sir Hudibras's squire, that obedience to civil government is not due because it is promised, he has come to exactly the same conclusion with respect to the obligation of keeping one's word. But Ralph has reasoned with more ingenuity; and has shown not only that the public good, but the glory of the Lord, may be sometimes promoted by a breach of faith.

* The faints are Godwin's rational and intelligent beings.

The faints,* whom oaths and vows oblige,
Know little of their privilege;
Farther, I mean, than carrying on
Some self-advantage of their own:
For if the dev'l, to serve his turn,
Can tell truth, why the faints should scorn,
When it serves theirs, to swear and lie,
I think there's little reason why:
Else h' has a greater pow'r than they,
Which 'twere impiety to say:
W' are not commanded to forbear,
Indefinitely, at all to swear;

But to swear idly, and in vain,
Without self-interest and gain;
For breaking of an oath and lying
Is but a kind of self-denying,
A faint-like virtue; and from hence
Some have broke oaths by Providence:
Some, to the glory of the Lord,
Perjur'd themselves and broke their word:—
For saints may do the same thing by
The spirit, in sincerity,
Which other men are tempted to,
And at the devil's instance do.

HUDIBRAS, Cant. II.

Here are new views of utility; which, were they to be considered as of any weight, would increase the difficulty of determining when an erroneous promise ought to be kept.

But should views of utility be laid aside, and should it be made an invariable rule that truth is on no account to be violated, that deceit is never to be practised, and that moral obligations are not to be dissolved for the prospect of any physical advantage; those doubts which arise concerning the validity of erroneous promises will soon disappear. Disagreeable perhaps and ridiculous consequences may sometimes arise to a few individuals from an honest and conscientious adherence to their promise; but will any assert that the general good, *that burden of the song*, will ever be endangered by too much veracity?

So numerous inconveniences arise daily from the regular operation of those great physical laws, which are under the immediate direction of Providence, that those philosophers who have adopted the principle of utility, and are much surprised to see the universe so awkwardly planned for the ease and comfort of them and their species, have been under the necessity of imputing many events in nature to the malignity of some evil independent being; or of allowing that things have degenerated since they first came from the hands of the Creator, and that they must now be exceedingly altered from what they had been when He chose to pronounce them all very good. Thus, absurdity or impiety must always be the consequence of judging of the vice and virtue of an action by its utility, and of estimating its utility by our limited views and erroneous conceptions.

As for extorted promises, it is curious to observe how this question should always be started, whether or not they ought to be kept? and another question should seldom be thought of, whether or not they ought to be made? Fortitude was one of the cardinal virtues among the ancients; and is deemed of such importance in the Christian system, that the fearful are classed with the unbelievers, and are thought unworthy of the favour of Deity, as being incapable of supporting those trials to which heaven exposes the faithful as the truest test of Christian virtue.—If a person should want the necessary fortitude to be virtuous, it will be a poor excuse for his baseness, that he has added deceit to his cowardice: and surely it is not the business of morality, when it has found him guilty of one crime, to grant him a dispensation for committing two. The laws of jurisprudence, it will readily be allowed, cannot favour the claims of the promisee; because they ought never to

Promise.

17
Views of utility an unsafe guide in morals.

18
Extorted promises,

19
Whether necessary fortitude to be virtuous, it will be a poor excuse for his baseness, that he has added deceit to his not.

Promise. to lend their support to oppression and violence. But their acquittal, should he violate his faith, will by no means vindicate the character of the promiser. Their acquitting a woman from the charge of adultery, goes a short way in restoring the fair reputation of her innocence.

Let jurisprudence decide as it will, the man of honour and the generous patriot can never be brought to respect the person who, struck with a panic, could betray either himself or his friends. The magnanimous spirits who could die for the truth will view with contempt his pitiful deceit. Those unfortunate men who may suffer from that very distrust which the breach of his faith has begotten, will always detest him as a traitor and enemy; and heaven itself cannot be supposed to reward that soldier who deserts her cause, and relinquishes the post which she has assigned him, at the sight of danger.

If we once begin to accommodate morality to the dispositions and humours of mankind, it is hard to say where this species of complaisance will end. The degrees of timidity are so various, and some tempers by nature so yielding, that repeated importunity or an earnest request will extort a promise.

20
The laws of morality are not to be accommodated to the humours and interests of mankind.

A young lady was frequently pressed by her dying husband to grant him a promise that she would not marry after his death. For some time she was able to resist with becoming spirit his absurd request; but upon his declaring oftener than once that he could not otherwise die in peace, she complied and promised. Too young, however, for this effort of continence, she afterwards listened to the addresses of a second lover, and found her heart insensibly engaged before she adverted to the impropriety of a new attachment. But proposals of marriage could scarcely fail to remind her of her promise and awaken her scruples. These she soon communicated to her lover, with her firm resolution to remain a widow, if the contrary measure, which she greatly preferred, and on which her earthly happiness depended, were not approved by some spiritual counsellor.

Upon this declaration it was agreed to take the advice of their own minister, who was an eminent dissenting clergyman in the diocese of Oxford: but this gentleman, unwilling to decide in a matter of such importance, proposed to refer it to Dr Secker, who was then bishop of that see. This prelate too declined to give any judgment in the case; but, as was his way, mustered up a number of arguments on each side of the question, and committed them to a letter, which a learned gentleman of our acquaintance had some time ago an opportunity of seeing in manuscript.

If the sentiments to which the bishop was inclined could have been inferred from his statement of arguments, he seemed to think that the promise was binding. In our opinion, he ought to have given a positive decision. It was no matter whether the promise was extorted or not: the promise was made; and the question was now, whether or not was the performance lawful? That it was lawful appears evident. The lady was under a moral obligation to remain a widow; and no moral obligation, so far as we know, required her to marry.

To be fruitful and multiply, indeed, is declared in Scripture, and is found, to the woful experience of many, to be one of the general laws of our nature. But of all those laws intended by nature to regulate the conduct of inferior intelligences, the moral, which were meant

to be checks and correctors of those abuses to which the physical are apt to be carried, are certainly the most sacred and obligatory. To procreate his species, a man is not then to be guilty of adultery, nor of fornication, nor to listen to the lewd calls of incontinency. St Paul's observation, that it is better to marry than burn, cannot be allowed in this instance to have much weight. He has not defined what degree of amorous inflammation constitutes burning, nor in what cases this burning would be a sufficient warrant for marrying. In the present instance he does not even consider marriage as a duty; he compares it with burning, and thinks it only the least of the two evils. Not that marriage is evil of itself; for he that marrieth doth well: but there are circumstances in which it would be inconvenient to marry, and in which he that marrieth not is said to do better. But if those inconveniences be reasons sufficient to deter from marrying, is that person to be held excusable who, in order to gratify an animal passion, somewhat refined, should violate an oath, and trample on a sacred moral obligation?

Promise.
21
Moral laws superior to physical in point of obligation.

The young lady might indeed declare that her earthly happiness was at an end if she were not permitted to marry again: but what circumstance prevented her from marrying? It was not the opinion of her own pastor, nor the bishop of Oxford: the truth is, it was certain scruples of her own, which being unable of herself to overcome, she had piously solicited the assistance of others. It is certainly a misfortune that a devotional and amorous turn should always be so closely connected in the females. Both, however, cannot always be indulged. Who will say, that the motive is rational which inclines one to cherish a passion which conscience disapproves? The virtue of continency might indeed have borne hard on this lady's constitution, and in her way to immortal happiness might have formed a gate so strait and narrow as it might be difficult for her to pass through: but after all, her case was not harder than that of nuns, who take the vows of perpetual chastity, and endure sufferings of a similar nature, and in some instances even perhaps greater than hers; yet doing it cheerfully, from the supposition that the Omniscient is well acquainted with the nature of the great sacrifice which they make, and that after death he will study to requite them, and bestow on them something like an equivalent, which in their opinion can scarcely be less than a happiness in heaven as ample as their wishes and as lasting as their souls.

Every promise, therefore, which is not released, nor fraudently obtained by the promisee, is to be held binding if the performance be lawful and possible.

The Christian cannot, and a man of honour will scarcely venture to reject this maxim, that a good man ought not to change though he swear to his hurt. Yet a simple promise and a promissory oath are not very different in point of obligation. Most people know, and, where any moral duty is concerned, they ought particularly to reflect, that this world is governed by an Almighty Being, who knows all things, who lives always, and who is just to reward and to punish. The person who makes a promissory oath does it avowedly under an immediate sense of these truths; the person who makes a simple promise, though he certainly ought, yet may not reflect on these at the time. The former, when he violates his oath, exhibits, only to outward appearance,

22
A promise of a similar nature with an oath.

Pronon-
tory
||
Pronuncia-
tion.

appearance, a greater contempt of the Divine power, knowledge, and justice, than he who violates a simple promise under an impression of the same truths. To Him who knows the secrets of the heart, the breach of the promise must appear as criminal as the breach of the oath. See ASSUMPSIT and OATH.

PROMONTORY, in geography, a high point of land or rock projecting out into the sea; the extremity of which towards the sea is called a *cape* or *headland*. See Plate CCXII.

PROMPTER, in the drama, an officer posted behind the scenes, whose business it is to watch attentively the actors speaking on the stage, in order to suggest and put them forward when at a stand, to correct them when amiss, &c. in their parts.

PROMULGATED, or PROMULGED, something published or proclaimed, and generally applied to a law, to denote the publishing or proclaiming it to the people.

PRONAOS, in the ancient architecture, a porch to a church, palace, or other spacious building. See the article PORCH.

PRONATION, among anatomists. The radius of the arm has two kinds of motions, the one called *pronation*, the other *supination*. Pronation is that whereby the palm of the hand is turned downwards; and supination, the opposite motion thereto, is that whereby the back of the hand is turned downwards. The peculiar muscles whereby pronation is performed, are called *pronatores*, as those by which supination is performed are termed *supinators*. See ANATOMY, Table of the Muscles, and Plates.

PRONG-HOE, in husbandry, a term used to express an instrument used to hoe or break the ground near and among the roots of plants.

The ordinary contrivance of the hoe is very defective, it being only made for scraping on the surface; but the great use of hoeing being to break and open the ground, beside the killing of the weeds, which the ancients, and many among us, have thought the only use of the hoe, this dull and blunt instrument is by no means calculated for the purposes it is to serve. The prong-hoe consists of two hooked points of six or seven inches long, and when struck into the ground will stir and remove it the same depth as the plough does, and thus answer both the ends of cutting up the weeds and opening the land. It is useful even in the horse-hoeing husbandry, because the hoe-plough can only come within three or four inches of the rows of the corn, turnips, and the like; whereas this instrument may be used afterwards, and with it the land may be raised and stirred even to the very stalk of the plant. See AGRICULTURE and HOE.

PRONOUN, PRONOMEN, in grammar, a declinable part of speech, which being put instead of a noun, points out some person or thing. See GRAMMAR.

PRONUNCIATION, in grammar, the manner of articulating or founding the words of a language.

Pronunciation makes the most difficult part of written grammar; in regard that a book expressing itself to the eyes, in a matter that wholly concerns the ears, seems next akin to that of teaching the blind to distinguish colours: hence it is that there is no part so defective in grammar as that of pronunciation, as the writer has frequently no term whereby to give the read-

er an idea of the sound he would express; for want of a proper term, therefore, he substitutes a vicious and precarious one. To give a just idea of the pronunciation of a language, it seems necessary to fix as nearly as possible all the several sounds employed in the pronunciation of that language. Cicero tells us, that the pronunciation underwent several changes among the Romans: and indeed it is more precarious in the living languages, being, as Du Bos tells us, subservient to fashion in these. The French language is clogged with a difficulty in pronunciation from which most others are free; and it consists in this, that most of their words have two different pronunciations, the one in common prose, the other in verse.

As to the pronunciation of the English language, the ingenious Mr Martin, in his Spelling-Book of Arts and Sciences, lays down the following rules: 1. The final (*e*) lengthens the sound of the foregoing vowel; as in *can, cane; rob, robe; tun, tune, &c.* 2. The final (*e*), in words ending in *re*, is sounded before the *r* like *u*; as *massacre, massu-cur; lucre, lu-cur, &c.* 3. The Latin diphthongs *a, æ*, are sounded like *e*; as *Ætna, Etna; æconomy, economy, &c.*: but at the end of the words *oe* sounds like *o*; as in *toe, joe, &c.* 4. Also the English improper diphthongs, *ea, eo, eu, ue*, sound only the *e* and *u*; as *tea or te; jeoffee or seffee; due or du; true or tru, &c.* though sometimes *eo* and *ea* are pronounced like *ee*, as in *people, fear, near, &c.* 5. Sometimes the diphthong (*ie*) is pronounced like *e* in *cieling*, like *ee* in *field*, and, at the end of words, always like *y*, as in *lie, &c.*; and *ei* is pronounced either like *e* or *ai*, as in *deceit, reign, &c.* 6. The triphthong *eau* is pronounced like *o*, in *beau* and *j-et d'eau*; and *ieu* sounds like *u* in *lieu, adieu, &c.* 7. The sound of *c* is hard before the vowels *a, o, u*, as in *call, cold, cup, &c.*; also sometimes before *b*, as in *chart, cold, &c.*; and before *l* and *r*, as in *clear, creep, &c.* It is otherwise generally soft, as in *city, cell, cyder, child, &c.* 8. In French words *ch* is sounded like *sh*, as in *chagreen, machine*; and sometimes like *qu*, as in *choir*. 9. The sound of *g* is hard before *a, o, u, l, r*, as in *gall, go, gum, glean, grope*; also before *ui*, as in *guilt, guild, &c.*; and before *h*, as in *ghost*; sometimes before *i*, as in *gibbous, gibberish*. It is also generally hard before *e*, as in *get, geld, &c.*; but soft in many words derived from the Greek and Latin, as in *geometry, genealogy, genus, &c.* Two *gg* are always hard, as in *dagger, &c.* The sound of *g*, when soft, is like that of *j*. 10. In any part of a word, *ph* sounds like *f*, as in *philosophy, &c.* 11. The sound of *qu*, at the end of French words, is like *k*, as in *risque, &c.* 12. The syllables *ti* and *ci*, if followed by a vowel, sound like *fi* or *shi*; as in *fiction, logician, &c.* 13. When *cc* occurs before *i*, the first is hard and the latter is soft; as in *flaccid, &c.* 14. The letter *p* is not pronounced at the beginning of syllables before *f* and *t*; as in *psalm, ptarmics, &c.* As to other peculiarities regarding the pronunciation of single letters, many of them have been taken notice of at the beginning of each, in the course of this work.

But it is not enough to know the just pronunciation of single letters, but also of words: in order to which, the accenting of words ought to be well understood; since nothing is more harsh and disagreeable to the ear, than to hear a person speak or read with wrong accents. And indeed in English the same word is often

Pronunciation, Proof. both a noun and a verb, distinguished only by the accent, which is on the first syllable of the noun, and on the last of the verb; as *ferment* and *ferment*; *record* and *record*, &c. We are to observe also, that in order to a just expression of words, some require only a single accent on the syllable, as in *tórmént*, &c.; but in others it should be marked double, as in *anímal*, because it is pronounced as if the letter was wrote double, viz. *anímal*.

Mr Sheridan's Dictionary will be found extremely useful as a directory in acquiring the pronunciation of the English language; but care must be taken to avoid his provincial brogue, which has certainly misled him in several instances. Mr Walker's Pronouncing Dictionary, lately published, will likewise deserve the student's attention. It is a work of great labour and merit, and is highly useful. It has indeed some faults and inaccuracies, but it is notwithstanding, in all probability, the best of the kind.

PRONUNCIATION is also used for the fifth and last part of rhetoric, which consists in varying and regulating the voice agreeably to the matter and words, so as most effectually to persuade and touch the hearers. See ORATORY, Part IV.

PROOF, in law and logic, is that degree of evidence which carries conviction to the mind. It differs from demonstration, which is applicable only to those truths of which the contrary is inconceivable. It differs likewise from probability, which produces for the most part nothing more than opinion, while proof produces belief. See PROBABILITY.

The *proof* of crimes was anciently effected among our ancestors divers ways; viz. by duel or combat, fire, water, &c. See DUEL and ORDEAL.

Proof of Artillery and Small Arms, is a trial whether they stand the quantity of powder allotted for that purpose. The rule of the board of ordnance is, that all guns, under 24-pounders, be loaded with powder as much as their shot weighs; that is, a brass 24-pounder with 21 lb. a brass 32-pounder with 26 lb. 12 oz. and a 42-pounder with 31 lb. 8 oz.; the iron 24-pounder with 18 lb. the 32-pounder with 21 lb. 8 oz. and the 42-pounder with 25 lb.

The brass light field-pieces are proved with powder that weighs half as much as their shot, except the 24-pounder, which is loaded with 10 lb only.

Government allows 11 bullets of lead in the pound for the proof of muskets, and 14.5, or 29 in two pounds, for service; 17 in the pound for the proof of carabines, and 20 for service; 28 in the pound for the proof of pistols, and 34 for service.

When guns of a new metal, or of lighter construction, are proved; then, besides the common proof, they are fired 200 or 300 times, as quick as they can be, loaded with the common charge given in actual service. Our light 6-pounders were fired 300 times in 3 hours 27 minutes, loaded with 1 lb. 4 oz. without receiving any damage.

Proof of Powder, is in order to try its goodness and strength. See GUNPOWDER.

Proof of Cannon, is made to ascertain their being well cast, their having no cavities in their metal, and, in a word, their being fit to resist the effort of their charge of powder. In making this proof, the piece is laid upon the ground, supported only by a piece of

wood in the middle, of about 5 or 6 inches thick, to raise the muzzle a little; and then the piece is fired against a solid butt of earth.

Tools used in the Proof of Cannon are as follow:

Searcher, an iron socket with branches, from 4 to 8 in number, bending outwards a little, with small points at their ends: to this socket is fixed a wooden handle, from 8 to 12 feet long, and 1½ inch in diameter. This searcher is introduced into the gun after each firing, and turned gently round to discover the cavities within: if any are found, they are marked on the outside with chalk; and then the

Searcher with one point is introduced: about which point a mixture of wax and tallow is put, to take the impression of the holes; and if any are found of one-fourth of an inch deep, or of any considerable length, the gun is rejected as unserviceable to the government.

Reliever, is an iron ring fixed to a handle, by means of a socket, so as to be at right angles; it serves to disengage the first searcher, when any of its points are retained in a hole, and cannot otherwise be got out. When guns are rejected by the proof-masters, they order them to be marked X thus, which the contractors generally alter WP thus; and after such alteration, dispose of them to foreign powers for Woolwich proof.

The most curious instrument for finding the principal defects in pieces of artillery, was lately invented by lieutenant-general Desaguliers, of the royal regiment of artillery. This instrument, grounded on the truest mechanical principles, is no sooner introduced into the hollow cylinder of the gun, than it discovers its defects, and more particularly that of the piece not being truly bored; which is a very important one, and to which most of the disasters happening to pieces of artillery are in a great measure to be imputed; for, when a gun is not truly bored, the most expert artillerist will not be able to make a good shot.

Proof of Mortars and Howitzers, is made to ascertain their being well cast, and of strength to resist the effort of their charge. For this purpose the mortar or howitzer is placed upon the ground, with some part of their trunnions or breech sunk below the surface, and resting on wooden billets, at an elevation of about 70 degrees.

The mirror is generally the only instrument to discover the defects in mortars and howitzers. In order to use it, the sun must shine; the breech must be placed towards the sun, and the glass over-against the mouth of the piece: it illuminates the bore and chamber sufficiently to discover the flaws in it.

Proof of Foreign Brass-Artillery. 1st, The Prussians. Their battering-train and garrison artillery are proved with a quantity of powder equal to ½ the weight of the shot, and fired 75 rounds as fast as in real service; that is, 2 or 3 rounds in a minute. Their light field-train, from a 12-pounder upwards, are proved with a quantity of powder = 1-3d. of the weight of the shot, and fired 150 rounds, at 3 or 4 rounds in a minute. From a 12-pounder downwards, are proved with a quantity of powder = 1-5th of the shot's weight, and fired 300 rounds, at 5 or 6 rounds each minute, properly spunged and loaded. Their mortars are proved with the chambers full of powder, and the shells loaded. Three rounds are fired as quick as possible.

2d, The Dutch prove all their artillery by firing each

Proof,
Propaga-
tion.

each piece 5 times; the two first rounds with a quantity of powder = 2-3ds of the weight of the shot; and the three last rounds with a quantity of powder = $\frac{1}{4}$ the weight of the shot.

3d. The French the same as the Dutch.

PROOF, in brandy and other spirituous liquors, is a little white lather which appears on the top of the liquor when poured into a glass. This lather, as it diminishes, forms itself into a circle called by the French the *chapelet*, and by the English the *bead* or *bubble*.

Nichols's
Life of Ho-
garth.

PROOFS of Prints, were anciently a few impressions taken off in the course of an engraver's process. He proved a plate in different states, that he might ascertain how far his labours had been successful, and when they were complete. The excellence of such early impressions, worked with care, and under the artist's eye, occasioning them to be greedily sought after, and liberally paid for, it has been customary among our modern printellers to take off a number of them, amounting, perhaps to hundreds, from every plate of considerable value; and yet their want of rareness has by no means abated their price. On retouching a plate, it has been also usual, among the same conscientious fraternity, to cover the inscription, which was immediately added after the first proofs were obtained, with slips of paper, that a number of secondary proofs might also be created.

PROOF, in the sugar trade. See SUGAR.

PROOFS, in printing. See PRINTING, p. 524, col. 2.

PROPAGATION, the act of multiplying the kind. See GENERATION.

PROPAGATION of Plants. The most natural and the most universal way of propagating plants is by seeds. See PLANTS, and NATURAL HISTORY, p. 654. But they may also be propagated by *sets*, *pieces*, or *cuttings*, taken from the parent plant. Willows are very easily propagated by sets: such as rise to be considerable timber trees being raised from sets 7 or 8 feet long, sharpened at their larger ends, which are thrust into the ground by the sides of ditches, on the banks of rivers, or in any moist soil. The fallow trees are raised from sets only 3 feet long. The plane tree, mint, &c. may be propagated in the same way. In providing the slips, sprigs, or cuttings, however, care must be taken to cut off such branches as have knots or joints 2 or 3 inches beneath them; small top sprigs of 2 or 3 years growth are the best for this operation. Plants are also propagated by parting their roots, each part of which, properly managed, sends out fresh roots. Another mode of propagating plants is by layering or laying the tops of the branches in the ground.

The method of layering is this: Dig a ring-trench round the stool, of a depth suitable to the nature of the plant; and having pitched upon the shoots to be layered, bend them to the bottom of the trench (either with or without plashing, as may be found most convenient), and there *peg* them fast; or, putting some mould upon them, *tread* them hard enough to prevent their springing up again—fill in the mould—place the top of the layer in an upright posture, treading the mould hard behind it; and cut it carefully off above the first, second, or third eye. Plants are also propagated by their bulbs.

The number of vegetables that may be propagated from an individual is very remarkable, especially in the most minute plants. The annual product of one seed

even of the common mallow has been found to be no less than 200,000; but it has been since proved, by a strict examination into the more minute parts of the vegetable world, that so despised a plant as the common wall moss produces a much more numerous offspring. In one of the little heads of this plant there have been counted 13824 seeds. Now allotting to a root of this plant eight branches, and to each branch six heads, which appears to be a very moderate computation, the produce of one seed is $6 \times 13824 = 82944$; and 8×82944 , gives 663,552 seeds as the annual produce of one seed, and that so small that 13824 of them are contained in a capsule, whose length is but one ninth of an inch, its diameter but one 23d of an inch, and its weight but the 13th part of a grain.

For the propagation or culture of particular plants, see AGRICULTURE, Part II. sect. 3. p. 288. and HUSBANDRY.

PROPER, something natural and essentially belonging to any thing.

PROPERTIUS (Sextus Aurelius), a celebrated Latin poet, born at Mevania, a city of Umbria, now called *Bevagna*, in the duchy of Spoleto. He went to Rome after the death of his father, a Roman knight, who had been put to death by order of Augustus, for having followed Antony's party during the triumvirate. Propertius in a short time acquired great reputation by his wit and abilities, and had a considerable share in the esteem of Mæcenæ and Cornelius Gallus. He had also Ovid, Tibullus, Bassus, and the other ingenious men of his time, for his friends. He died at Rome 19 B. C. He is printed with almost all the editions of Tibullus and Catullus: but the best edition of him is that which was given separately by Janus Brouckhusius at Amsterdam, 1702, in 4to, and again in 1714, 4to. *cum curis secundis ejusdem*. We have four books of his Elegies or Amours with a lady called *Hosilia*, or *Hosilia*, to whom he gave the name of *Cynthia*.

PROPERTY, in a general sense, is a particular virtue or quality which nature has bestowed on some things exclusive of all others: thus, colour is a property of light; extension, figure, divisibility, and impenetrability, are properties of body.

PROPERTY, in law, is described to be the highest right which a person has or can have to any thing. Definition.

There is nothing which so generally strikes the imagination, and engages the affections of mankind, as the right of property; or that sole and despotic dominion which one man claims and exercises over certain external things of the world, in total exclusion of the right of any other individual in the universe. And yet there are very few that will give themselves the trouble to consider the original and foundation of this right. Pleased as we are with the possession, we seem afraid to look back to the means by which it was acquired, as if fearful of some defect in our title; or at best we rest satisfied with the decision of the laws in our favour, without examining the reason or authority upon which those laws have been built. We think it enough that our title is derived by the grant of the former proprietor, by descent from our ancestors, or by the last will and testament of the dying owner: not caring to reflect, that (accurately and strictly speaking) there is no foundation in nature or in natural law, why a set of words upon parchment should convey the dominion of land; why the son should have a right to exclude his fellow-creatures from a de- The original foundation of the right to property is not generally considered.

Proper
Property.

Property. a determinate spot of ground, because his father had done so before him; or why the occupier of a particular field or of a jewel, when lying on his death-bed and no longer able to maintain possession, should be entitled to tell the rest of the world which of them should enjoy it after him. These inquiries, it must be owned, would be useless and even troublesome in common life. It is well if the mass of mankind will obey the laws when made, without scrutinizing too nicely into the reasons of making them. But when law is to be considered not only as a matter of practice, but also as a rational science, it cannot be improper or useless to examine more deeply the rudiments and grounds of these positive constitutions of society.

3
This right
arises from
a divine
grant.

In the beginning of the world, we are informed by holy writ, that the all-bountiful Creator gave to man "dominion over all the earth; and over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth." This is the only true and solid foundation of man's dominion over external things, whatever airy metaphysical notions may have been started by fanciful writers upon this subject. The earth, therefore, and all things therein, are the general property of all mankind, exclusive of other beings, from the immediate gift of the Creator. And, while the earth continued thinly inhabited, it is reasonable to suppose, that all was in common among them, and that every one took from the public stock to his own use such things as his immediate necessities required.

4
The state
of property
in the early
ages of the
world.

These general notions of property were then sufficient to answer all the purposes of human life; and might perhaps still have answered them, had it been possible for mankind to have remained in a state of primæval simplicity: as may be collected from the manners of many American nations, when first discovered by the Europeans; and from the ancient method of living among the first Europeans themselves, if we may credit either the memorials of them preserved in the golden age of the poets, or the uniform accounts given by historians of those times wherein *erant omnia communia et indivisa omnibus, veluti unum cunctis patrimonium esset*. Not that this communion of goods seems ever to have been applicable, even in the earliest ages, to aught but the *substance* of the thing; nor could it be extended to the *use* of it. For, by the law of nature and reason, he who first began to use it, acquired therein a kind of transient property, that lasted so long as he was using it, and no longer: or, to speak with greater precision, the *right* of possession continued for the same time only that the *act* of possession lasted. Thus the ground was in common, and no part of it was the permanent property of any man in particular; yet whoever was in the occupation of any determinate spot of it, for rest, for shade, or the like, acquired for the time a sort of ownership, from which it would have been unjust, and contrary to the law of nature, to have driven him by force; but the instant that he quitted the use or occupation of it, another might seize it without injustice. Thus also a vine or other tree might be said to be in common, as all were equally entitled to its produce; and yet any private individual might gain the sole property of the fruit, which he had gathered for his own repast. A doctrine well illustrated by Cicero, who compares the world to a great theatre, which is common to the public, and yet the place which any man has taken is for the time his own.

Blackst:
Comment.

But when mankind increased in number, craft, and ambition, it became necessary to entertain conceptions of more permanent dominion; and to appropriate to individuals, not the immediate *use* only, but the very *substance* of the thing to be used: otherwise innumerable tumults must have arisen, and the good order of the world been continually broken and disturbed, while a variety of persons were striving who should get the first occupation of the same thing, or disputing which of them had actually gained it. As human life also grew more and more refined, abundance of conveniences were devised to render it more easy, commodious, and agreeable; as habitations for shelter and safety, and raiment for warmth and decency. But no man would be at the trouble to provide either, so long as he had only an usufructuary property in them, which was to cease the instant that he quitted possession;—if, as soon as he walked out of his tent, or pulled off his garment, the next stranger who came by would have a right to inhabit the one and to wear the other. In case of habitations in particular, it was natural to observe, that even the brute creation, to whom every thing else was in common, maintained a permanent property in their dwellings, especially for the protection of their young; that the birds of the air had nests, and the beasts of the field had caverns, the invasion of which they esteemed a very flagrant injustice, and would sacrifice their lives to preserve them. Hence a property was soon established in every man's house and home-stall; which seem to have been originally mere temporary huts or moveable cabins, suited to the design of Providence for more speedily peopling the earth, and suited to the wandering life of their owners, before any extensive property in the soil or ground was established. And there can be no doubt, but that moveables of every kind became sooner appropriated than the permanent substantial soil: partly because they were more susceptible of a long occupancy, which might be continued for months together without any sensible interruption, and at length by usage ripen into an established right; but principally because few of them could be fit for use, till improved and meliorated by the bodily labour of the occupant; which bodily labour, bestowed upon any subject which before lay in common to all men, is universally allowed to give the fairest and most reasonable title to an exclusive property therein.

The article of food was a more immediate call, and therefore a more early consideration. Such as were not contented with the spontaneous product of the earth sought for a more solid refreshment in the flesh of beasts, which they obtained by hunting. But the frequent disappointments incident to that method of provision induced them to gather together such animals as were of a more tame and sequacious nature; and to establish a permanent property in their flocks and herds, in order to sustain themselves in a less precarious manner, partly by the milk of their dams, and partly by the flesh of the young. The support of these their cattle made the article of *water* also a very important point. And therefore the book of Genesis (the most venerable monument of antiquity, considered merely with a view to history) will furnish us with frequent instances of violent contentions concerning wells; the exclusive property of which appears to have been established in the first digger or occupant, even in such places where the ground and herbage remained.

6
In food
there were
not only
necessary
articles,

7
Nature of
patriarchal
property.

Property. remained yet in common. Thus we find Abraham, who was but a sojourner, asserting his right to a well in the country of Abimelech, and exacting an oath for his security, "because he had digged that well." And Isaac, about 90 years afterwards, reclaimed this his father's property; and, after much contention with the Philistines, was suffered to enjoy it in peace.

All this while the soil and pasture of the earth remained still in common as before, and open to every occupant: except perhaps in the neighbourhood of towns, where the necessity of a sole and exclusive property in lands (for the sake of agriculture) was earlier felt, and therefore more readily complied with. Otherwise, when the multitude of men and cattle had consumed every convenience on one spot of ground, it was deemed a natural right to seize upon and occupy such other lands as would more easily supply their necessities. This practice is still retained among the wild and uncultivated nations that have never been formed into civil states, like the Tartars and others in the east; where the climate itself, and the boundless extent of their territory, conspire to retain them still in the same savage state of vagrant liberty, which was universal in the earliest ages, and which Tacitus informs us continued among the Germans till the decline of the Roman empire. We have also a striking example of the same kind in the history of Abraham and his nephew Lot. When their joint substance became so great, that pasture and other conveniences grew scarce, the natural consequence was, that a strife arose between their servants; so that it was no longer practicable to dwell together. This contention Abraham endeavoured to compose: "Let there be no strife, I pray thee, between thee and me. Is not the whole land before thee? Separate thyself, I pray thee, from me: If thou wilt take the left hand, then I will go to the right; or if thou depart to the right hand, then I will go to the left." This plainly implies an acknowledged right, in either, to occupy whatever ground he pleased, that was not pre-occupied by other tribes. "And Lot lifted up his eyes, and beheld all the plain of Jordan, that it was well watered everywhere, even as the garden of the Lord. Then Lot chose him all the plain of Jordan, and journeyed east; and Abraham dwelt in the land of Canaan."

Upon the same principle was founded the right of migration, or sending colonies to find out new habitations, when the mother-country was overcharged with inhabitants; which was practised as well by the Phœnicians and Greeks, as the Germans, Scythians, and other northern people. And, so long as it was confined to the stocking and cultivation of desert uninhabited countries, it kept strictly within the limits of the law of nature.

8
Necessity of property and of laws respecting it.
But as the world by degrees grew more populous, it daily became more difficult to find out new spots to inhabit, without encroaching upon former occupants; and by constantly occupying the same individual spot, the fruits of the earth were consumed, and its spontaneous produce destroyed, without any provision for a future supply or succession. It therefore became necessary to pursue some regular method of providing a constant subsistence; and this necessity produced, or at least promoted and encouraged, the art of agriculture. And the art of agriculture, by a regular connection and consequence, introduced and established the idea

of a more permanent property in the soil than had hitherto been received and adopted. It was clear that the earth would not produce her fruits in sufficient quantities without the assistance of tillage; but who would be at the pains of tilling it, if another might watch an opportunity to seize upon and enjoy the product of his industry, art, and labour? Had not therefore a separate property in lands, as well as moveables, been vested in some individuals, the world must have continued a forest, and men have been mere animals of prey; which, according to some philosophers, is the genuine state of nature. Whereas now (so graciously has Providence interwoven our duty and our happiness together) the result of this very necessity has been the ennobling of the human species, by giving it opportunities of improving in *rational* faculties, as well as of exerting its *natural*. Necessity begat property: and in order to insure that property, recourse was had to civil society, which brought along with it a long train of inseparable concomitants; states, government, laws, punishments, and the public exercise of religious duties. Thus connected together, it was found that a part only of society was sufficient to provide, by their manual labour, for the necessary subsistence of all; and leisure was given to others to cultivate the human mind, to invent useful arts, and to lay the foundations of science.

9
The only question remaining is, How this property became actually vested; or what it is that gave a man an exclusive right to retain in a permanent manner that specific land which before belonged generally to every body, but particularly to nobody? And as we before observed, that *occupancy* gave the right to the temporary use of the soil; so it is agreed upon all hands, that occupancy gave also the original right to the permanent property in the *substance* of the earth itself, which excludes every one else but the owner from the use of it. There is indeed some difference among the writers on natural law, concerning the reason why occupancy should convey this right, and invest one with this absolute property: Grotius and Puffendorf insisting, that this right of occupancy is founded upon a tacit and implied assent of all mankind, that the first occupant should become the owner; and Barbeyrac, Titius, Mr Locke, and others, holding, that there is no such implied assent, neither is it necessary that there should be; for that the very act of occupancy, alone, being a degree of bodily labour, is from a principle of natural justice, without any consent or compact, sufficient of itself to gain a title. A dispute that favours too much of nice and scholastic refinement. However, both sides agree in this, that occupancy is the thing by which the title was in fact originally gained; every man seizing to his own continued use such spots of ground as he found most agreeable to his own convenience, provided he found them unoccupied by any one else.

10
Property, both in lands and moveables, being thus originally acquired by the first taker, which taking amounts to a declaration, that he intends to appropriate the thing to his own use, it remains in him, by the principle of universal law, till such time as he does some other act which shows an intention to abandon it; for then it becomes, naturally speaking, *publici juris* once more, and is liable to be again appropriated
By what means it is preserved or lost.

^{Property.} ted by the next occupant. So if one is possessed of a jewel, and casts it into the sea or a public highway, this is such an express dereliction, that a property will be vested in the first fortunate finder that shall seize it to his own use. But if he hides it privately in the earth, or other secret place, and it is discovered, the finder acquires no property therein; for the owner hath not by this act declared any intention to abandon it, but rather the contrary: and if he loses or drops it by accident, it cannot be collected from thence that he designed to quit the possession; and therefore in such case the property still remains in the loser, who may claim it again of the finder. And this, we may remember, is the doctrine of the English law with relation to *TREASURE-TROVE*.

But this method, of one man's abandoning his property, and another seizing the vacant possession, however well founded in theory, could not long subsist in fact. It was calculated merely for the rudiments of civil society, and necessarily ceased among the complicated interests and artificial refinements of polite and established governments. In these it was found, that what became inconvenient or useless to one man, was highly convenient and useful to another; who was ready to give in exchange for it some equivalent that was equally desirable to the former proprietor. This mutual convenience introduced commercial traffic, and the reciprocal transfer of property by sale, grant, or conveyance: which may be considered either as a continuance of the original possession which the first occupant had; or as an abandoning of the thing by the present owner, and an immediate successive occupancy of the same by the new proprietor. The voluntary dereliction of the owner, and delivering the possession to another individual, amount to a transfer of the property; the proprietor declaring his intention no longer to occupy the thing himself, but that his own right of occupancy shall be vested in the new acquirer. Or, taken in the other light, if I agree to part with an acre of my land to Titius, the deed of conveyance is an evidence of my intending to abandon the property; and Titius, being the only or first man acquainted with such my intention, immediately steps in and seizes the vacant possession: thus the consent expressed by the conveyance gives Titius a good right against me; and possession or occupancy confirms that right against all the world besides.

¹¹
How it goes on the death of the occupant.
The most universal and effectual way of abandoning property is by the death of the occupant: when, both the actual possession and intention of keeping possession ceasing, the property, which is founded upon such possession and intention, ought also to cease of course. For, naturally speaking, the instant a man ceases to be, he ceases to have any dominion: else, if he had a right to dispose of his acquisitions one moment beyond his life, he would also have a right to direct their disposal for a million of ages after him; which would be highly absurd and inconvenient (A). All property must therefore cease upon death, considering men as absolute individuals, and unconnected with ci-

VOL. XV. Part II.

vil society: for then, by the principles before established, the next immediate occupant would acquire a right in all that the deceased possessed. But as, under civilized governments, which are calculated for the peace of mankind, such a constitution would be productive of endless disturbances, the universal law of almost every nation (which is a kind of secondary law of nature) has either given the dying person a power of continuing his property, by disposing of his possessions by will; or, in case he neglects to dispose of it, or is not permitted to make any disposition at all, the municipal law of the country then steps in, and declares who shall be the successor, representative, or heir of the deceased; that is, who alone shall have a right to enter upon this vacant possession, in order to avoid that confusion which its becoming again common would occasion. And farther, in case no testament be permitted by the law, or none be made, and no heir can be found so qualified as the law requires, still, to prevent the robust title of *occupancy* from again taking place, the doctrine of escheats is adopted in almost every country; whereby the sovereign of the state, and those who claim under his authority, are the ultimate heirs, and succeed to those inheritances to which no other title can be formed.

¹²
The right of inheritance, or descent to the children of the deceased, seems to have been allowed much earlier than the right of devising by testament. We are apt to conceive at the first view that it has nature on its side; yet we often mistake for nature what we find established by long and inveterate custom. It is certainly a wise and effectual, but clearly a political, establishment; since the permanent right of property, vested in the ancestor himself, was no natural, but merely a civil, right. It is true, that the transmission of one's possessions to posterity has an evident tendency to make a man a good citizen and a useful member of society: it sets the passions on the side of duty, and prompts a man to deserve well of the public, when he is sure that the reward of his services will not die with himself, but be transmitted to those with whom he is connected by the dearest and most tender affections. Yet, reasonable as this foundation of the right of inheritance may seem, it is probable that its immediate original arose not from speculations altogether so delicate and refined, and, if not from fortuitous circumstances, at least from a plainer and more simple principle. A man's children or nearest relations are usually about him on his death-bed, and are the earliest witnesses of his decease. They became therefore generally the next immediate occupants, till at length in process of time this frequent usage ripened into general law. And therefore also in the earliest ages, on failure of children, a man's servants born under his roof were allowed to be his heirs; being immediately on the spot when he died. For we find the old patriarch Abraham expressly declaring, that "since God had given him no seed, his steward Eliezer, one born in his house, was his heir."

While property continued only for life, testaments

4 F

were

(A) This right, inconvenient as it certainly is, the law of Scotland gives to every man over his *real* estate, by authorising him to entail it on his heirs for ever. See LAW, clxxx. 9, 10, 11. and TAILZIE.

Property.
13
Last will
or testa-
ments

were useless and unknown; and when it became inheritable, the inheritance was long indefeasible, and the children or heirs at law were incapable of exclusion by will. Till at length it was found, that so strict a rule of inheritance made heirs disobedient and headstrong, defrauded creditors of their just debts, and prevented many provident fathers from dividing or charging their estates as the exigence of their families required. This introduced pretty generally the right of disposing of one's property, or a part of it, by *testament*; that is, by written or oral instructions properly *witnessed* and authenticated, according to the *pleasure* of the deceased; which we therefore emphatically style his *will*. This was established in some countries much later than in others. In England, till modern times, a man could only dispose of one-third of his moveables from his wife and children; and, in general, no will was permitted of lands till the reign of Henry VIII. and then only of a certain portion; for it was not till after the Restoration that the power of devising real property became so universal as at present.

14
Are crea-
tures of the
civil or
municipal
laws.

Blackst.
Comment.

Wills, therefore, and testaments, rights of inheritance, and successions, are all of them creatures of the civil or municipal laws, and accordingly are in all respects regulated by them; every distinct country having different ceremonies and requisites to make a testament completely valid; neither does any thing vary more than the right of inheritance under different national establishments. In England particularly, this diversity is carried to such a length, as if it had been meant to point out the power of the laws in regulating the succession to property, and how futile every claim must be that has not its foundation in the positive rules of the state. In personal estates, the father may succeed to his children; in landed property, he never can be their immediate heir by any the remotest possibility: in general, only the eldest son, in some places only the youngest, in others all the sons together, have a right to succeed to the inheritance: In real estates, males are preferred to females, and the eldest male will usually exclude the rest; in the division of personal estates, the females of equal degree are admitted together with the males, and no right of primogeniture is allowed.

15
Scruples
respecting
heritable
property
removed.

This one consideration may help to remove the scruples of many well-meaning persons, who set up a mistaken conscience in opposition to the rules of law. If a man disinherits his son, by a will duly executed, and leaves his estate to a stranger, there are many who consider this proceeding as contrary to natural justice; while others so scrupulously adhere to the supposed intention of the dead, that if a will of lands be attested by only *two* witnesses instead of *three*, which the law requires, they are apt to imagine that the heir is bound in conscience to relinquish his title to the devisee. But both of them certainly proceed upon very erroneous principles: as if, on the one hand, the son had by nature a right to succeed to his father's lands; or as if, on the other hand, the owner was by nature entitled to direct the succession of his property after his own decease. Whereas the law of nature suggests, that on the death of the possessor, the estate should again become common, and be open to the next occupant, unless otherwise ordered, for the sake of civil

peace, by the positive law of society. The positive law of society, which is with us the municipal laws of England and Scotland, directs it to vest in such person as the last proprietor shall by will, attended with certain requisites, appoint; and, in defect of such appointment, to go to some particular person, who, from the result of certain local constitutions, appears to be the heir at law. Hence it follows, that, where the appointment is regularly made, there cannot be a shadow of right in any one but the person appointed: and, where the necessary requisites are omitted, the right of the heir is equally strong and built upon as solid a foundation, as the right of the devisee would have been, supposing such requisites were observed.

But, after all, there are some few things, which, notwithstanding the general introduction and continuance of property, must still unavoidably remain in common; being such wherein nothing but an usufructuary property is capable of being had: and therefore they still belong to the first occupant, during the time he holds possession of them, and no longer. Such (among others) are the elements of light, air, and water; which a man may occupy by means of his windows, his gardens, his mills, and other conveniences; such also are the generality of those animals which are said to be *feræ nature*, or of a wild and untameable disposition; which any man may seize upon and keep for his own use or pleasure. All these things, so long as they remain in possession, every man has a right to enjoy without disturbance; but if once they escape from his custody, or he voluntarily abandons the use of them, they return to the common stock, and any other man has an equal right to seize and enjoy them afterwards.

Again, there are other things in which a permanent property may subsist, not only as to the temporary use, but also the solid substance; and which yet would be frequently found without a proprietor, had not the wisdom of the law provided a remedy to obviate this inconvenience. Such are forests and other waste grounds, which were omitted to be appropriated in the general distribution of lands: such also are wrecks, estrays, and that species of wild animals, which the arbitrary constitutions of positive law have distinguished from the rest by the well-known appellation of *game*. With regard to these and some others, as disturbances and quarrels would frequently arise among individuals contending about the acquisition of this species of property by first occupancy, the law has therefore wisely cut up the root of dissension, by vesting the things themselves in the sovereign of the state; or else in his representatives appointed and authorised by him, being usually the lords of manors. And thus our legislature has universally promoted the grand ends of civil society, the peace and security of individuals, by steadily pursuing that wise and orderly maxim, of assigning to every thing capable of ownership a legal and determinate owner.

In this age of paradox and innovation, much has been said of *liberty* and *equality*; and some few have contended for an equalization of property. One of the wildest declaimers on this subject, who is for abolishing property altogether, has (inadvertently we suppose) given a complete confutation, not only of his own arguments, but also of the arguments of all who have

16
Of things
that are
still in com-
mon.

17
Of similar
things
which have
been appro-
priated.

18
The reason-
ing of
those who
contend for
an equali-
zation of
property.

Property,
Prophecy.

have written, or, we think, can write, on the same side of the question. After labouring to prove that it is gross injustice in any man to retain more than is absolutely necessary to supply him with food, clothes, and shelter, this zealous reformer states an objection to his theory, arising from the well-known allurements of sloth, which, if the accumulation of property were not permitted, would banish idleness from the whole world. The objection he urges fairly, and answers it thus: "It may be observed, that the equality for which we are pleading is an equality that would succeed to a state of great intellectual improvement. So bold a revolution cannot take place in human affairs, till the general mind has been highly cultivated. The present age of mankind is greatly enlightened; but it is to be feared is not yet enlightened enough. Hasty and undigested tumults may take place, under the idea of an equalization of property; but it is only a calm and clear conviction of justice, of justice mutually to be rendered and received, of happiness to be produced by the *desertion of our most rooted habits*, that can introduce an invariable system of this sort. Attempts without this preparation will be productive only of confusion. Their effect will be momentary, and a new and more barbarous inequality will succeed. Each man with unaltered appetite will watch his opportunity to gratify his love of power, or his love of distinction, by usurping on his inattentive neighbours."

19
The effect
of igno-
rance of
human na-
ture.

These are just observations, and such as we have often made to ourselves on the various proposed reformations of government. The illumination which the author requires before he would introduce his abolition of property, would constitute men more than angels; for to be under the influence of no passion or appetite, and to be guided in every action by unmixed benevolence and pure intellect, is a degree of perfection which we can attribute to no being inferior to God. But it is the object of the greater part of this writer's book to prove that all men must arrive at such perfection before his ideal republic can contribute to their happiness; and therefore every one who is conscious of being at any time swayed by passion, and who feels that he is more attached to his wife or children than to strangers, will look without envy to the present inequalities of property and power, if he be an intelligent disciple of Mr Godwin.

1
Definition.

Literary PROPERTY. See COPY-RIGHT.

PROPHECY is a word derived from *προφητεία*, and in its original import signifies the prediction of future events.

2
Prophecy
proves a
superna-
tural com-
munion
with the
Deity.

As God alone can perceive with certainty the future actions of free agents, and the remote consequences of those laws of nature which he himself established, prophecy, when clearly fulfilled, affords the most convincing evidence of an intimate and supernatural communion between God and the person who uttered the prediction. Together with the power of working miracles, it is indeed the only evidence which can be given of such a communion. Hence among the professors of every religious system, except that which is called the religion of nature, there have been numberless pretenders to the gift of prophecy. The Pagan nations of antiquity had their oracles, augurs, and soothsayers. Modern idolaters have their necromancers and diviners; and the

3
The pro-
fessors of
all religi-
ons
have pre-
tended to
it.

Jews, Christians, and Mahometans, have their seers and prophets.

The ill-founded pretensions of paganism, ancient and modern, have been exposed under various articles of this work. (See DIVINATION, MAGIC, NECROMANCY, and MYTHOLOGY). And the claims of the Arabian impostor are examined under the articles ALCO-RAN and MAHOMETANISM; so that at present we have only to consider the use, intent, and truth, of the Jewish and Christian prophecies.

Previous to our entering on this investigation, it may be proper to observe, that in the Scriptures of the Old and New Testaments, the signification of the word prophecy is not always confined to the foretelling of future events. In several instances it is of the same import with preaching, and denotes the faculty of illustrating and applying to present practical purposes the doctrines of prior revelation. Thus in Nehemiah it is said, "Thou hast appointed prophets to preach;" and whoever speaketh unto men to edification, and exhortation, and comfort, is by St Paul called a *prophet*. Hence it was that there were schools of prophets in Israel, where young men were instructed in the truths of religion, and fitted to exhort and comfort the people.

In this article, however, it is chiefly of importance to confine ourselves to that kind of prophecy which, in declaring truths either past, present, or future, required the immediate inspiration of God.

Every one who looks into the history of the world must observe, that the minds of men have from the beginning been gradually opened by a train of events still improving upon, and adding light to each other; as that of each individual is, by proceeding from the first elements and seeds of science, to more enlarged views, and a still higher growth. Mankind neither are nor ever have been capable of entering into the depths of knowledge at once; of receiving a whole system of natural or moral truths together; but must be let into them by degrees, and have them communicated by little and little, as they are able to bear it. That this is the case with respect to human science, is a fact which cannot be questioned; and there is as little room to question it with respect to the progress of religious knowledge among men, either taken collectively or in each individual. Why the case is thus in both, why all are not adult at once in body and mind, is a question which the religion of nature is equally called upon with revelation to answer. The fact may not be easily accounted for, but the reality of it is incontrovertible.

Accordingly, the great object of the several revelations recorded in the Old Testament was evidently to keep alive a sense of religion in the minds of men, and to train them by degrees for the reception of those simple but sublime truths by which they were to be saved. The notions which the early descendants of Adam entertained of the Supreme Being, and of the relation in which they stood to him, were probably very gross; and we see them gradually refined by a series of revelations or prophecies, each in succession more explicit than that by which it was preceded, till the advent of Him who was the way, the truth, and the life, and who brought to light life and immortality.

When a revelation was made of any important truth, the grounds of which the mind of man has not facul-

4
The word
in Scrip-
ture has va-
rious mean-
ings.

* Ch. vi.
v. 7.
† 1. Cor.
ch. xiv.
v. 3.

5
Science and
religion
gradually
acquired.

6
The reve-
lations of
the Old
Testament
gradual.

Prophecy. ties to comprehend, that revelation, though undoubtedly a prophecy, must have been so far from confirming the truth of revealed religion in general, that it could not gain credit itself, but by some extrinsic evidence that it came indeed from God. Hence we find Moses, after it was revealed to him from the burning bush that he should deliver his countrymen from Egyptian bondage, replying, "Behold, they will not believe me, nor hearken to my voice; for they will say, the Lord hath not appeared unto thee." This revelation certainly constituted him a prophet to Israel; and there cannot be a doubt but that he perfectly knew the divine source from which he received it: but he very naturally and reasonably concluded, that the children of Israel would not believe that the Lord had appeared to him, unless he could give them some other proof of this preternatural appearance than his own simple affirmation of its reality. This proof he was immediately enabled to give, by having conferred upon him the power of working miracles in confirmation of his prophecy. Again, when Gideon was called to the deliverance of Israel, the angel of the Lord came and said unto him, "The Lord is with thee, thou mighty man of valour: go in this thy might, and thou shalt save Israel from the hand of the Midianites. Have not I sent thee?" Here was a prophecy delivered by the angel of the Lord to encourage Gideon's undertaking: but he, being probably afraid of some illusion of sense or imagination, demanded a sign that he was really an angel who talked with him. A sign is accordingly given him, a miraculous sign, with which he is satisfied, and undertakes the work appointed him.

8
And of itself can be no proof of a revelation.

From these and many similar transactions recorded in the Old Testament, it appears that prophecy was never intended as evidence of an original revelation. It is indeed, by its very nature, totally unfit for such a purpose; because it is impossible, without some extrinsic proof of its divine origin, to know whether any prophecy be true or false, till the era arrive at which it ought to be fulfilled. When it is fulfilled, it affords complete evidence that he who uttered it spake by the spirit of God, and that the doctrines which he taught of a religious nature, were all either dictated by the same spirit, or at least are true, and calculated to direct mankind in the way of their duty.

9
It was intended to preserve a sense of religion among men.

The prophecies vouchsafed to the patriarchs in the most early periods of the world, were all intended to keep alive in their minds a sense of religion, and to direct their views to the future completion of that first and greatest prophecy which was made to Adam immediately on his fall: but in order to secure credit to those prophecies themselves, they were always accompanied by some miraculous sign that they were indeed given by the God of truth, and not the delusions of fanaticism or hypocrisy. Prophecy, in the proper sense of the word, commenced with the fall; and the first instance of it is implied in the sentence denounced upon the original deceiver of mankind; "I will put enmity between thee and the woman, and between thy seed and her seed: It shall bruise thy head, and thou shalt bruise his heel."

10
Probable effects of the first prophecy on our first parents.

This prophecy, though one of the most important that ever was delivered, when considered by itself, is exceedingly obscure. That Adam should have understood it, as some of his degenerate sons have pretended

to do, in a literal sense, is absolutely impossible. He knew well that it was the great God of heaven and earth who was speaking, and that such a Being was incapable of trifling with the wretchedness of his fallen creature. The sentence denounced upon himself and his wife was awful and severe. The woman was doomed to sorrow in conception; the man to sorrow and travel all the days of his life. The ground was cursed for his sake; and the end of the judgment was, "Dust thou art, and to dust thou shalt return." Had our first parents been thus left, they must have looked upon themselves as rejected by their Maker, delivered up to trouble and sorrow in the world, and as having no hope in any other. With such impressions on their minds they could have retained no sense of religion; for religion, when unaccompanied by hope, is a state of frenzy and distraction: yet it is certain that they could have no hope from any thing expressly recorded by Moses, except what they might draw from this sentence passed on their deceiver. Let us then endeavour to ascertain what consolation it could afford them.

At that awful juncture, they must have been sensible that their fall was the victory of the serpent, whom by experience they had found to be an enemy to God and to man. It could not therefore but be some comfort to them to hear this enemy first condemned, and to see that, however he had prevailed against them, he had gained no victory over their Maker. By his condemnation they were secured from thinking that there was any malignant being equal to the Creator in power and dominion; an opinion which, through the prevalency of evil, gained ground in after times, and was destructive of all true religion. The belief of God's supreme dominion being thus preserved, it was still necessary to give them such hopes as might induce them to love as well as to fear him; and these they could not but conceive when they heard from the mouth of their Creator and Judge, that the serpent's victory was not complete even over themselves; that they and their posterity should be enabled to contest his empire; and that though they were to suffer much in the struggle, they should yet finally prevail, bruise the serpent's head, and deliver themselves from his power and dominion.

This prophecy therefore was to our first parents a light shining in a dark place. All that they could certainly conclude from it was, that their case was not desperate; that some remedy, some deliverance from the evil they were under, would in time appear; but *when* or *where*, or by *what means* they were to be delivered, they could not possibly understand, unless the matter was further revealed to them, as probably it was at the institution of sacrifice (See SACRIFICE). Obscure, however, as this promise or prophecy was, it served after the fall as a foundation for religion, and trust and confidence towards God in hopes of deliverance in time from the evils of disobedience: and this appears to have been the sole purpose for which it was given, and not, as some well-meaning though weak advocates for Christianity have imagined, as a prediction pointing *directly* to the cross of Christ.

As this prophecy was the first, so is it the only considerable one in which we have any concern from the creation to the days of Noah. It was proportioned to the then wants and necessities of the world, and was the grand charter of God's mercy after the fall. Nature

had

Prophecy. had no certain help for sinners; her rights were lost with her innocence. It was therefore necessary either to destroy the offenders, or to raise them to a capacity of salvation, by giving them such hopes as might enable them to exercise a reasonable religion. So far the light of this prophecy extended. By what means God intended to work their salvation, he did not expressly declare: and who has a right to complain that he did not, or to prescribe to him rules in dispensing his mercy to the children of men?

11
The curse removed from the ground.

* Use and Intent of Prophecy.

Upon the hopes of mercy which this prophecy gives in very general terms, mankind rested till the birth of Noah. At that period a new prophecy was delivered by Lamech, who foretels that his son should comfort them concerning the work and toil of their hands, "because of the *earth which the Lord had cursed.*" We are to remember that the curse pronounced upon the earth was part of the sentence passed upon our first parents; and when that part was remitted, if it ever was remitted, mankind would acquire new and more lively hopes that in God's good time they should be freed from the whole. But it has been shown by bishop Sherlock*, that this declaration of Lamech's was a prediction, that during the life of his son the curse should be taken off from the earth: and the same prelate has proved with great perspicuity, and in the most satisfactory manner, that this happy revolution actually took place after the flood. The limits prescribed to an article of this kind will not permit us even to abridge his arguments. We shall only observe, that the truth of his conclusion is manifest from the very words of scripture; for when God informs Noah of his design to destroy the world, he adds, "But with thee will I establish my covenant:" and as soon as the deluge was over, he declared that he "would not again curse the ground any more for man's sake; but that while the earth should remain, seed-time and harvest, and cold and heat, and summer and winter, and day and night, should not cease." From this last declaration it is apparent that a curse *had* been on the earth, and that seed-time and harvest had often failed; that the curse was now taken off; and that in consequence of this covenant, as it is called, with Noah and his seed and with every living creature, mankind should not henceforth be subjected to toil so severe and so generally fruitless.

12
A future life not then explicitly revealed.

It may seem surprising perhaps to some, that after so great a revolution in the world as the deluge made, God should say nothing to the remnant of mankind of the punishments and rewards of another life, but should make a new covenant with them relating merely to fruitful seasons and the blessings of the earth. But in the scriptures we see plainly a gradual working of providence towards the redemption of the world from the curse of the fall; that the temporal blessings were first restored as an earnest and pledge of better things to follow; and that the covenant given to Noah had, strictly speaking, nothing to do with the hopes of futurity, which were reserved to be the matter of another covenant, in another age, and to be revealed by him, whose province it was to "bring life and immortality to light through the gospel." But if Noah and his forefathers expected deliverance from the whole curse of the fall, the actual deliverance from one part of it was a very good pledge of a further deliverance to be expected in time. Man himself was cursed as well as the ground; he was doomed to dust: and fruitful seasons

are but a small relief, compared to the greatness of his loss. But when fruitful seasons came, and one part of the curse was evidently abated, it gave great assurance that the other should not last for ever, but that by some means, still unknown to them, they should be freed from the whole, and finally bruise the serpent's head, who, at the deluge, had so severely bruised man's heel.

Upon this assurance mankind rested for some generations, and practised, as we have every reason to believe, a rational worship to the one God of the universe. At last, however, idolatry was by some means or other introduced (see POLYTHEISM), and spread so universally through the world, that true religion would in all probability have entirely failed, had not God visibly interposed to preserve such a sense of it as was necessary for the accomplishment of his great design to restore mankind. This he did by calling Abraham from amidst his idolatrous kindred, and renewing to him the word of Abraham's prophecy: "Get thee out of thy country (said he), and from thy kindred, and from thy father's house, unto a land that I will shew thee. And I will make of thee a great nation, and I will bless thee and make thy name great; and thou shalt be a blessing. And I will bless them that bless thee, and curse him that curseth thee; and in thee shall all the families of the earth be blessed." These magnificent promises are several times repeated to the father of the faithful with additional circumstances of great importance, such as, "that he should be multiplied exceedingly; that he should be a father of many nations; that kings should come out of him;" and above all, that God would establish an *everlasting covenant* with him and his seed, to give him and them all the land of Canaan for an *everlasting possession*, and to be *their God.*"

Upon such of these promises as relate to temporal blessings we need not dwell. They are much of the same nature with those which had been given before to Lamech, Noah, Shem, and Japheth; and all the world knows how amply and literally they have been fulfilled. There was however so little probability in nature of their accomplishment at the time when they were made, that we find the patriarch asking "Whereby he should *know* † that he should inherit such an extent of country?" And as the promises that he should inherit it were meant to be a foundation for religion and confidence in God, a miraculous sign was given him that they came indeed from the spirit of truth. This removed from his mind every doubt, and made him give the fullest credit, not only to them, but also to that other promise, "that in his seed should all the nations of the earth be blessed."

What distinct notion he had of this blessing, or in what manner he hoped it should be effected, we cannot pretend to say. "But that he understood it to be a promise of restoring mankind, and delivering them from the remaining curse of the fall, there can be no doubt. He knew that death had entered by sin; he knew that God had promised victory and redemption to the seed of the woman. Upon the hopes of this restoration the religion of his ancestors was founded; and when God, from whom this blessing on all men was expected, did expressly promise a blessing on all men, and in this promise founded his everlasting covenant—what could Abraham else expect but the completion in his seed of that ancient promise and prophecy concerning the victory

Prophecy.

13
Promise to Abraham,

† Genesis xv. 8. &c.

Prophecy. to be obtained by the woman's seed? The curse of the ground was expiated in the flood, and the earth restored with a blessing, which was the foundation of the temporal covenant with Noah; a large share of which God expressly grants to Abraham and his posterity particularly, together with a promise to bring, by their means, a new and further blessing upon the whole race of men. If we lay these things to heart, we cannot suppose that less could be expected from the new promise or prophecy given to Abraham than a deliverance from that part of the curse still remaining on men: *Dust thou art, and to dust thou shalt return.* In virtue of this covenant Abraham and his posterity had reason to expect that the time would come when man should be called from his dust again. For this expectation they had his assurance who gave the covenant, that he would be their God for ever. Well might our Saviour then tell the sons of Abraham, that even Moses at the bush showed the resurrection of the dead, when he called the Lord the God of Abraham, and the God of Isaac, and the God of Jacob *."

* Sher-
lock's Use
and Intent
of Prophecy.

14
To Isaac
and Jacob.

15
The law of
Moses and
the suc-
ceeding
prophets

These promises made to Abraham were renewed to Isaac and Jacob; to the last of whom it was revealed, not only that all the nations of the earth should be blessed in his seed, but that the blessing should spring from his son Judah. It is, however, by no means evident that any one of those patriarchs knew precisely by what means (A) the curse of the fall was to be entirely removed, and all men called from their dust again. It was enough that they were convinced of the fact in general terms, since such conviction was a sufficient foundation of a rational religion; and the descendants of Abraham had no other foundation upon which to rest their hopes, and pay a cheerful worship to the God of their fathers, till the giving of the law to Moses. Then indeed they were incorporated into a society with municipal laws of their own and placed under a theocratic government; the temporal promises made to their fathers were amply fulfilled; religion was maintained among them by rewards and punishments equally distributed in this world (see THEOLOGY): and a series of prophets succeeding one another pointed out with greater and greater clearness, as the fulness of time approached, the person who was to redeem mankind from the power of death; by what means he was to work that great redemption, and at what precise period he was to make his appearance in the world. By these supernatural interpositions of divine providence, the principles of pure theism and the practice of true religion were preserved among the children of Israel, when all other nations were sunk in the grossest idolatry, and wallowed in the most abominable vices; when the far-famed Egyptians, Greeks, and Romans, fell down with adoration

to stocks and stones and the vilest reptiles; and when **Prophecy.** they had no well grounded hope of another life, and were in fact without God in the world.

From this short deduction, we think ourselves intitled to conclude, that the *primary* use and intent of prophecy, under the various dispensations of the Old Testament, was not, as is too often supposed, to establish the divine mission of Jesus Christ, but to keep alive in the minds of those to whom it was given, a sense of religion, and a hope of future deliverance from the curse of the fall. It was, in the expressive language of St Peter, "a light that shone in a dark place, unto which men did well to take heed until the day dawned and the day-star arose in their hearts." But though this was certainly the original intent of prophecy (for Christ, had he never been foretold, would have proved himself to be the Son of God with power by his astonishing miracles, and his resurrection from the dead), yet it cannot be denied, that a long series of prophecies, given in different and far distant ages, and having all their completion in the life, death, and resurrection, of Jesus, concur very forcibly with the evidence of miracles to prove that he was the seed of the woman ordained to bruise the head of the serpent, and restore man to his forfeited inheritance. To the Jews the force of this evidence must have been equal, if not superior, to that of miracles themselves; and therefore we find the Apostles and first preachers of the gospel, in their addresses to them, constantly appealing to the law and the prophets, whilst they urged upon the Gentiles the evidence of miracles.

In order to form a right judgment of the argument for the truth of Christianity drawn from the sure word of prophecy, we must not consider the prophecies given in the Old Testament as so many *predictions* only independent of each other; for if we do, we shall totally lose sight of the purpose for which they were originally given, and shall never be able to satisfy ourselves when confronted by the objections of unbelievers. It is easy for men of leisure and tolerable parts to find difficulties in particular predictions, and in the application of them made by writers, who lived many hundred years ago, and who had many ancient books and records of the Jewish church, from which they drew many passages, and perhaps some prophecies; which books and records we have not to enable us to understand, and to justify their applications. But it is not so easy a matter to show, or to persuade the world to believe, that a chain of prophecies reaching through several thousand years, delivered at different times, yet manifestly subservient to one and the same administration of providence from beginning to end, is the effect of art and contrivance and religious fraud. In examining the several prophecies

16
Were all
intended to
keep alive
a sense of
religion.

17
The pro-
phesies to
be consid-
ered in
connection.

(A) This they certainly could not know from the promises expressed in the very general terms in which they are recorded in the book of Genesis. It is, however, not improbable that those promises, as they immediately received them, were conceived in terms more precise and particular; and, at all events, Dr Warburton has proved to the full conviction of every man who is not a determined unbeliever, that Abraham was commanded to sacrifice his son Isaac, not only as a trial of his obedience, but also that God might give him what he earnestly desired, a scenical representation of the means by which mankind were to be redeemed from death. The learned writer thinks, and his reasoning compels us to think with him, that to this transaction our Saviour alludes when he says, "Your father Abraham rejoiced to see my day, and he saw it and was glad."

Prophecy. cies recorded in the Old Testament, we are not to suppose that each of them *expressly* pointed out and *clearly* characterized Jesus Christ. Had they done so, instead of being a support to religion in general, the purpose for which they were originally intended, they would have had a very different effect, by making those to whom they were given repine at being placed under dispensations so very inferior to that of the gospel. We are therefore to inquire only whether all the notices, which, in general and often metaphorical terms, God gave to the fathers of his intended salvation, are perfectly answered by the coming of Christ; and we shall find that nothing has been promised with respect to that subject which has not been performed in the amplest manner. If we examine the prophecies in this manner, we shall find that there is not one of them, which the Apostles have applied to the Messiah, that is not applicable in a rational and important sense to something in the birth, life, preaching, death, resurrection, and ascension of Jesus of Nazareth; that as applied to him they are all consistent with each other; and that though some few of them may be applied without absurdity to persons and events under the Jewish dispensation, Christ is the only person that ever existed in whom they all meet as in a centre. In the limits prescribed us, it is impossible that we should enter upon a particular proof of this position. It has been proved by numberless writers, and, with respect to the most important prophecies, by none with greater success than bishop Sherlock in his *Use and Intent of Prophecy in the several ages of the world*; a work which we recommend to our readers as one of the most valuable on the subject in our own or any other language.

18
Objection
from the
obscurity
of prophe-
cy.

But admitting that it would have been improper, for the reasons already hinted at, to have given a clear and precise description of Christ, and the Christian dispensation, to men who were ordained to live under dispensations less perfect, how, it may be asked, comes it to pass that many of the prophecies applied by the writers of the gospel to our Saviour and his actions are still dark and obscure, and so far from belonging evidently to him and to him only, that it requires much learning and sagacity to show even now the connection between some prophecies and the events?

19
Answered.

In answer to these questions, the learned prelate just referred to observes, "That the obscurity of prophecy does not arise from hence, that it is a relation or description of something *future*; for it is as easy to speak of things future plainly, and intelligibly, as it is of things past or present. It is not, therefore, of the nature of prophecy to be obscure; for it may easily be made, when he who gives it thinks fit, as plain as history. On the other side, a figurative and dark description of a future event will be figurative and dark still when the event happens; and consequently will have all the obscurity of a figurative and dark description as well after as before the event. The prophet Isaiah describes the peace of Christ's kingdom in the following manner: 'The wolf shall dwell with the lamb, and the leopard shall lie down with the kid, and the calf and the young lion, and the fatling, together, and a little child shall lead them.' Nobody, some modern Jews excepted, ever understood this literally; nor can it now be *literally* applied to the state of the gospel. It was and is capable of different interpretations: it may mean tem-

poral peace, or that internal and spiritual peace—that tranquillity of mind, which sets a man at peace with God, himself, and the world. But whatever the true meaning is, this prophecy does no more obtrude one determinate sense upon the mind since the coming of Christ than it did before. But then we say, the state of the gospel was very properly prefigured in this description, and is as properly prefigured in a hundred more of the like kind; and since they all agree in a fair application to the state of the gospel, we strongly conclude, that this state was the thing foretold under such expressions. So that the argument from prophecy for the truth of Christianity does not rest on this, that the event has necessarily limited and ascertained the particular sense and meaning of every prophecy; but in this, that every prophecy has in a proper sense been completed by the coming of Christ. It is absurd, therefore, to expect clear and evident conviction from every single prophecy applied to Christ; the evidence must arise from a view and comparison of all together." It is doubtless a great mistake to suppose that prophecy was intended solely or chiefly for their sakes in whose time the events predicted are to happen. What great occasion is there to lay in so long beforehand the evidence of prophecy to convince men of things that are to happen in their own times; the truth of which they may, if they please, learn from their own senses? Yet some people are apt to talk as if they thought the truth of the events predicted depended very much on the evidence of prophecy: they speak, for instance, as if they imagined the certainty and reality of our Saviour's resurrection were much concerned in the clearness of the prophecies relating to that great and wonderful event, and seem to think that they are confusing the truth of his resurrection when they are pointing out the absurdity of the prophecies relating to it. But can any thing be more absurd? For what ground or pretence is there to inquire whether the prophecies foretelling that the Messiah should die and rise again do truly belong to Christ, unless we are first satisfied that Christ died and rose again?

The part which unbelievers ought to take in this question, if they would make any use of prophecy, should be, to show from the prophets that Christ was necessarily to rise from the dead; and then to prove that in fact Jesus never did rise. Here would be a plain consequence. But if they like not this method, they ought to let the prophecies alone; for if Christ did not rise, there is no harm done though the prophets have not foretold it. And if they allow the resurrection of Christ, what do they gain by discrediting the prophets? The event will be what it is, let the prophecies be what they will.

These considerations show how far the gospel is *necessarily* concerned in prophetic evidence, and how clear the prophecies should be. Christ claims to be the person foretold in the law and the prophets; and as truth must ever be consistent with itself, this claim must be true as well as all others. This is the part then to be tried on the evidence of prophecy: Is Christ that person described and foretold under the Old Testament or not? Whether all the prophecies relating to him be plain or not plain, it matters little; the single question is, Are there enough plain to show us that Christ is the person foretold under the Old Testament? If there be,

we

Prophecy we are at an end of our inquiry, and want no farther help from prophecy; especially since we have seen the day dawn and enjoyed the marvellous light of the gospel of God.

20
Objections
from the
clearness of
some prop-
hecies,

But so unreasonable are unbelievers, that whilst some of them object to the obscurity of the prophecies, others have rejected them altogether on account of their clearness, pretending that they are histories and not predictions. The prophecies against which this objection has been chiefly urged are those of Daniel, which were first called in question by the famous Porphyry. He affirmed that they were not composed by Daniel, whose name they bear, but by some author who lived in Judea about the time of Antiochus Epiphanes; because all to that time contained true history, but that all the facts beyond that were manifestly false.

21
Answered,

This method of opposing the prophecies, as a father of the church rightly observes, is the strongest testimony of their truth: for they are so exactly fulfilled, that to infidels the prophet seemed not to have foretold things future, but to have related things past. To an infidel of this age, if he has the same ability and knowledge of history that Porphyry had, all the subsequent prophecies of Daniel, except those which are still fulfilling, would appear to be history and not prophecy: for it entirely overthrows the notion of their being written in the days of *Antiochus Epiphanes*, or of the *Maccabees*, and establishes the credit of Daniel as a prophet beyond contradiction, that there are several of those prophecies which have been fulfilled since that period as well as before; nay, that there are prophecies of Daniel which are fulfilling at this very time in the world.

22
From what
has happen-
ed since
the objec-
tion was
first started

Our limits will not permit us to enter into the objections which have been made to this prophet by the author of *The Literal Scheme of Prophecy considered*; nor is there occasion that we should enter into them. They have been all examined and completely answered by Bishop Chandler in his *Vindication of his Defence of Christianity*, by Mr Samuel Chandler in his *Vindication of the Antiquity and Authority of Daniel's Prophecies*, and by Bishop Newton in his excellent *Dissertations on the Prophecies*. To these authors we refer the reader; and shall conclude the present article with a view of some prophecies given in very remote ages, which are in this age receiving their accomplishment.

23
And from
facts of the
present
age.

Of these the first is that of Noah concerning the servitude of the posterity of Canaan. In the greater part of original manuscripts, and in our version of the holy scriptures, this prophecy is thus expressed: "Curfed be Canaan; a servant of servants shall he be unto his brethren:" but in the Arabic version, and in some copies of the Septuagint, it is, "Curfed be *Ham* the father of Canaan; a servant of servants shall he be to his brethren." Whether the curse was really pronounced upon Ham, which we think most probable, or only upon his son Canaan, we shall find the prediction remarkably fulfilled, not barely ages after the book of Genesis was very generally known, but also at this very day. It is needless to inform any man who has but looked into the Old Testament, that when the ancient patriarchs pronounced either a curse or a blessing upon any of their sons, they meant to declare the future fortunes, not of that son individually, but of his descendants as a tribe or a nation. Let us keep this in mind,

and proceed to compare with Noah's prophecy *first Prophecy* the fortunes of the descendants of Canaan, the fourth son of Ham, and then the fortunes of the posterity of Ham by his other sons.

With the fate of the Canaanites every reader is acquainted. They were conquered by Joshua several centuries after the delivery of this prophecy; and such of them as were not exterminated were by him and Solomon reduced to a state of the lowest servitude to the Israelites, the posterity of Shem the brother of Ham. The Greeks and Romans, too, who were the descendants of Japheth, not only subdued Syria and Palestine, but also pursued and conquered such of the Canaanites as were anywhere remaining, as for instance the Tyrians and Carthaginians, of whom the former were ruined by Alexander and the Grecians, and the latter by Scipio and the Romans. Nor did the effects of the curse stop there. The miserable remainder of that devoted people have been ever since slaves to a foreign yoke; first to the Saracens who are descended from Shem, and afterwards to the Turks who are descended from Japheth; and under the Turkish dominion they groan at this day.

If we take the prophecy as it stands in the Arabic version, its accomplishment is still more remarkable. The whole continent of Africa was peopled principally by the posterity of Ham. And for how many ages have the better parts of that country lain under the dominion first of the Romans, then of the Saracens, and now of the Turks? In what wickedness, ignorance, barbarity, slavery, and misery, live most of its inhabitants? and of the poor negroes how many thousands are every year sold and bought like beasts in the market, and conveyed from one quarter of the world to do the work of beasts in another; to the full accomplishment indeed of the prophecy, but to the lasting disgrace of those who are from the love of gain the instruments of fulfilling it. Nothing can be more complete than the execution of the sentence as well upon Ham as upon Canaan; and the hardiest infidel will not dare to say that it was pronounced after the event.

The next prophecy which we shall notice is that of Abraham concerning the multitude of his descendants; which every one knows is still fulfilled in the Jews even in their dispersed state, and therefore cannot have been given after the event of which it speaks.

Of the same kind are the several prophecies concerning Ishmael; of which some have been fulfilled, and others are at present fulfilling in the most astonishing manner. Of this son of Abraham it was foretold, that "he should be a wild man; that his hand should be against every man, and every man's hand against him; that he should dwell in the presence of all his brethren; that he should be multiplied exceedingly, beget twelve princes, and become a great nation." The sacred historian who records these prophecies adds, that "God was with the lad, and he grew, and dwelt in the wilderness, and became an archer."

To show how fully and literally all these prophecies have been accomplished, would require more room than we have to bestow; and to the reader of history the labour would be superfluous. We shall therefore only request the unbeliever to attend to the history of the Arabs, the undoubted descendants of Ishmael; and to say how it comes to pass, that though they have been robbers by land and pirates by sea for time immemorial,

Prophecy. rial, though their hands have been against every man, and every man's hand against them, they always have dwelt, and at this day dwell, in the presence of their brethren, a free and independent people. It cannot be pretended that no attempt has ever been made to conquer them; for the greatest conquerors in the world have all in their turns attempted it: but though some of them made great progress, not one was ever crowned with success. It cannot be pretended that the inaccessibleness of their country has been their protection; for their country has been often penetrated, though it never was entirely subdued. When in all human probability they have been on the brink of ruin, they were signally and providentially delivered. Alexander was preparing an expedition against them, when he was cut off in the flower of his age. Pompey was in the career of his conquests, when urgent affairs called him elsewhere. Ailius Gallius had penetrated far into their country, when a fatal disease destroyed great numbers of his men, and obliged him to return. Trajan besieged their capital city, but was defeated by thunder and lightning and whirlwinds. Severus besieged the same city twice, and was twice repelled from before it. The Turks, though they were able to wrest from them their foreign conquests, have been so little able to subdue the Arabs themselves, or even to restrain their depredations, that they are obliged to pay them a sort of annual tribute for the safe passage of the pilgrims who go to Mecca to pay their devotions. On these facts we shall not exclaim. He who is not struck upon comparing the simple history of this singular people with the prophecies so long ago delivered of them and their great ancestor, whose love of liberty is compared to that of the wild ass, would rise wholly unmoved from our exclamations.

24
The dispersion of the Jews plainly foretold,

A fourth prophecy of this kind, which cannot be alleged to have been uttered after the event, is the denunciation of Moses against the children of Israel in case of their disobedience; which is so literally fulfilled, that even at this moment it appears rather a history of the present state of the Jews, than a remote prediction of their apostacy and punishment. "And the Lord shall scatter thee among all people from the one end of the earth even unto the other. And among these nations shalt thou find no ease, neither shall the sole of thy foot have rest; but the Lord shall give thee there a trembling heart, and failing of eyes, and sorrow of mind. And thy life shall hang in doubt before thee; and thou shalt fear day and night, and shalt have none assurance of thy life." (Deut. xxviii. 64, 65, 66.) "And thou shalt become an astonishment, a proverb, and a by-word, among all nations, whither the Lord shall lead you." (Deut. xxviii. 37.)

Similar to this denunciation, but attended with some circumstances still more wonderful, is the following prediction of the prophet Hosea: "The children of Israel shall abide many days without a king, and without a prince, and without a sacrifice, and without an image, and without an ephod, and without teraphim. Afterwards shall the children of Israel return, and seek the

Vol. XV. Part II.

Lord their God, and David their king; and shall fear the Lord and his goodness in the latter days (A)" In this passage we find the state of the Jews for the last 1700 years clearly and distinctly described with all its circumstances. From the time that they rejected their Messiah all things began to work towards the destruction of their politics both civil and religious; and within a few years from his death, their city, temple, and government, were utterly ruined; and they themselves, not carried into a gentle captivity, to enjoy their laws, and live under governors of their own as they did in Babylon, but they were sold like beasts in a market, and became slaves in the strictest sense; and from that day to this have had neither prince nor chief among them. Nor will any one of them ever be able, after all their pretences, to prove his descent from Aaron, or to say with certainty whether he is of the tribe of Judah or of the tribe of Levi, till he shall discover that unknown country where never mankind dwelt, and where the apocryphal Esdras has placed their brethren of the ten tribes. This being the case, it is impossible they can have either an altar, or a sacrifice, or a priesthood, according to the institution of Moses, but are evidently an outcast people living under laws which cannot be fulfilled.

The cause of this deplorable condition is likewise assigned with the same perspicuity: They are scattered over the face of the earth, because they do not acknowledge Christ for the Messiah; because they do not submit to their own king, the true David. In the prophetic writings the name of David is frequently given to the Messiah, who was to descend from that prince. Thus Ezekiel, speaking of the kingdom of Christ, says, "I will set up one Shepherd over them, and he shall feed them, even my servant David; he shall feed them, and he shall be their shepherd." And Jeremiah says, "They shall serve the Lord their God, and David their king, whom I will raise up unto them."

That in these places, as well as in the passage under consideration, the Messiah is meant, is undeniable; for David the son of Jesse was dead long before any of the three prophets was born; and by none of them it is said, "afterwards David their king shall come again;" but "afterwards the children of Israel shall return to David their king," they shall recover from their blind infatuation, and seek him whom they have not yet known. By their not receiving Jesus for the Christ, they have forfeited all claim to the divine favour, and are, of consequence, "without a king, and without a chief, and without a sacrifice, and without an altar, and without a priesthood."

The time, however, will come, when they shall return and seek "the Lord their God and David their king;" when they shall tremble before him whom their fathers crucified, and honour the son even as they honour the father. That this part of the prophecy will in time be as completely fulfilled as the other has been, may be confidently expected from the wonderful preservation of the Jews for so many ages. Scattered as they

4 G

(B) Such is our translation of this remarkable prophecy; but the Greek version of the Seventy has it, perhaps more properly, thus: "The children of Israel shall abide many days without a king, and without a chief, and without sacrifice, and without an altar, and without a priesthood, and without prophecies. Afterwards," &c.

Prophecy. they are over the whole earth, and hated as they are by all nations, it might naturally be thought, that in process of time they would have coalesced with their conquerors, and have been ultimately absorbed and annihilated by the union, so that not a trace of them should now have remained; yet the fact is, that, dispersed as they have ever since been over the whole face of the globe, they have never, in a single instance in any country, lost their religious or national distinctions; and they are now generally supposed to be as numerous as they were under the reigns of David and Solomon. This is contrary to all history, and all experience of the course of human affairs in similar cases; it has been boldly and justly styled a standing miracle. Within 1000 or 1200 years back, a great variety of extraordinary and important revolutions have taken place among the nations of Europe. In the southern part of this island the Britons were conquered by the Saxons, the Saxons by the Danes, and the Danes and Saxons by the Normans; but in a few centuries these opposite and hostile nations were consolidated into one indistinguishable mass. Italy, about the same time that Britain was subdued by the Saxons, was conquered by the Goths and Vandals: and it is not easy to conceive a more striking contrast than that which subsisted between the polished inhabitants of that delightful country and their savage invaders; and yet how soon did all distinction cease between them! In France, the Roman colonies gradually assimilated with the ancient Gauls; and in Spain, though the Moors continued for several ages, and till their final expulsion, a distinct people, yet after they were once reduced to a state of subjection, their numbers very sensibly diminished; and such of them as were suffered to remain after their last overthrow have been long since so blended with the Spaniards that they cannot now be distinguished. But with regard to the Jews, the wonder is, that though they do not in any country where they are settled bear any proportion to the natural inhabitants, though they are universally reduced to a state of the lowest subjection, and even exposed to hatred, contempt, and persecution; yet in no instance does there seem to be the least appearance or probability of their numbers being diminished, in no instance do they discover any decay of attachment to their religious principles. Whence then comes it that this people alone, who, having no form of government or a republic anywhere subsisting, are without the means by which other people are kept united and distinct, should still be preserved amongst so many different nations? How comes it, when they have been thus scattered into so many distant corners, like dust which cannot be perceived, that they should still so long survive the dissolution of their own state, as well as that of so many others? To these questions the answer is obvious: They are preserved, that, as a nation, "they may return and seek the Lord their God and David their king, and fear the Lord and his goodness in the latter days."

27
Of prophe-
cies re-
specting
the Chris-
tian
church.

We might here subjoin many prophecies both from the Old and the New Testament, and especially from the writings of St Paul and St John, which so clearly describe the various fortunes of the Christian church, her progress to that state of general corruption under which she was sunk three centuries ago, and her gradual restoration to her primitive purity, that they cannot be supposed to proceed from the cunning craftiness

of men, or to have been written after the events of which they speak. To do justice to these, however, would require a volume, and many excellent volumes have been written upon them. The reader who wishes for satisfaction on so interesting a subject will do well to consult the writings of Mr Mede and Sir Isaac Newton, together with Bishop Newton's Dissertations, and the Sermons of Hurd, Halifax, and Bagot, preached at Warburton's lecture. We shall only observe, that one of the ablest reasoners that Great Britain ever produced, after having paid the closest attention to the predictions of the New Testament, hath been bold enough to put the truth of revealed religion itself upon the reality of that prophetic spirit which foretold the desolation of Christ's church and kingdom by antichrist. "If (says he), IN THE DAYS OF ST PAUL AND ST JOHN, there was any footstep of such a sort of power as this in the world; or if there HAD BEEN any such power in the world; or if there WAS THEN any appearance or probability that could make it enter into the heart of man to imagine that there EVER COULD BE any such kind of power in the world, much less in the temple or church of God; and if there be not now such a power actually and conspicuously exercised in the world; and if any picture of this power, DRAWN AFTER THE EVENT, can now describe it more plainly and exactly than it was originally described in the words of the prophecy—then may it, with some degree of plausibility, be suggested, that the prophecies are nothing more than enthusiastic imaginations."

Upon the whole, we conclude with Bishop Sherlock, that the various prophecies recorded in the Holy Scriptures were given, not to enable man to foresee with clearness future events, but to support the several dispensations of religion under which they were respectively promulgated. The principal prophecies recorded in the Old Testament led mankind to hope for a complete deliverance from the curse of the fall; and therefore tended to fill their minds with gratitude, and to enforce a cheerful obedience to that God who in the midst of judgment remembereth mercy. The prophecies, whether in the Old or New Testament, that portray the present state of the Jews, and the various fortunes of the Christian church, as they are daily fulfilling in the presence of all men, are the strongest possible proof of the divinity of our holy religion, and supply to us in the latter days the place of miracles, by which it was at first established.

PROPHET, in general, a person who foretels future events; but is particularly applied to such inspired persons among the Jews as were commissioned by God to declare his will and purposes to that people. Among the canonical books of the Old Testament we have the writings of 16 prophets, four of whom are denominated the *greater prophets*, viz. Isaiah, Jeremiah, Ezekiel, and Daniel; so called from the length or extent of their writings, which exceed those of the others, viz. Hosea, Joel, Amos, Obadiah, Jonah, Micah, Nahum, Habakkuk, Haggai, Zechariah, and Malachi, who are called the *lesser prophets*, from the shortness of their writings. The Jews do not place Daniel among the prophets, because, they say, he lived the life of a countier rather than that of a prophet. An account of the several writings of the prophets may be seen each under its particular head. See the article ISAAH, &c.

Prophet
||
Proportion.

Sons of the PROPHETS, in scripture history, an appellation given to young men who were educated in the schools or colleges under a proper master, who was commonly, if not always, an inspired prophet, in the knowledge of religion and in sacred music, and thus were qualified to be public preachers; which seems to have been part of the business of the prophets on the Sabbath-days and festivals. It is probable that God generally chose the prophets, whom he inspired, out of these schools. See PROPHECY.

PROPTIATION, in theology, a sacrifice offered to God to assuage his wrath and render him propitious. Among the Jews there were both ordinary and public sacrifices, as holocausts, &c. offered by way of thanksgiving; and extraordinary ones, offered by particular persons guilty of any crime, by way of propitiation. The Romish church believe the mass to be a sacrifice of propitiation for the living and the dead. The reformed churches allow of no propitiation but that one offered by Jesus Christ on the cross. See SACRIFICE.

PROPTIATORY, any thing rendering God propitious; as we say *propitiatory* sacrifices, in contradistinction to sacrifices which were *eucharistica*. Among the Jews the propitiatory was the cover or lid of the ark of the covenant; which was lined both within and without with plates of gold, inasmuch that there was no wood to be seen. This propitiatory was a type or figure of Christ, whom St Paul calls the propitiatory ordained from all ages. See *ARK of the Covenant*.

PROPOLIS, the name of a certain substance more tenacious than wax, with which the bees stop up all the holes or cracks in the sides of their hives. See BEE, n^o 13.

PROPONTIS, or SEA OF MARMORA, a part of the Mediterranean, dividing Europe from Asia; it has the Hellespont or canal of the Dardanelles to the south-west, whereby it communicates with the Archipelago, and the ancient Bosphorus of Thrace, or Strait of Constantinople, to the north-east, communicating with the Black or Euxine Sea. It has two capes: that on the Asia side is on a cape, where formerly stood a temple of Jupiter. The castle of Europe is on an opposite cape, and had anciently a temple of Serapis. It is 120 miles long, and in some places upwards of 40 miles broad.

PROPORTION, the identity or similitude of two ratios. Hence quantities that have the same ratio between them are said to be proportional; *e. gr.* if A be to B as C to D, or 8 be to 4 as 30 to 15; A, B, C, D, and 8, 4, 30, and 15, are said to be in proportion, or are simply called proportionals. Proportion is frequently confounded with ratio; yet have the two in reality very different ideas, which ought by all means to be distinguished. Ratio is properly that relation or habitude of two things, which determines the quantity of one from the quantity of another, without the intervention of any third: thus we say the ratio of 5 and 10 is 2, the ratio of 12 and 24 is 2. Proportion is the sameness or likeness of two such relations: thus the relations between 5 and 10 and 12 and 24 being the same, or equal, the four terms are said to be in proportion. Hence ratio exists between two numbers, but proportion requires at least three. Proportion, in fine, is the habitude or relation of two ratios when compared toge-

ther; as ratio is of two quantities. See ALGEBRA, A-*Proportion*, RITHMETIC, and GEOMETRY.

Arithmetical and Geometrical PROPORTION. See PROGRESSION.

Harmonical or Musical PROPORTION, is a kind of numerical proportion formed thus: of three numbers, if the first be to the third as the difference of the first and second to the difference of the second and third; the three numbers are in harmonical proportion.

Thus 2, 3, 6, are harmonical, because $2:6::1:3$. So also four numbers are harmonical, when the first is to the fourth as the difference of the first and second to the difference of the third and fourth.

Thus 24, 16, 12, 9, are harmonical, because $24:9::8:3$. By continuing the proportional terms in the first case, there arises an harmonical progression or series.

1. If three or four numbers in harmonical proportion be multiplied or divided by the same number; the products or quotients will also be in harmonical proportion: thus, if 6, 8, 12, which are harmonical, be divided by 2, the quotients 3, 4, 6, are also harmonical; and reciprocally their products by 2, viz. 6, 8, 12.

2. To find an harmonical mean between two numbers given; divide double the product of the two numbers by their sum, the quotient is the mean required; thus suppose 3 and 6 the extremes, the product of these is 18, which doubled gives 36; this divided by 9 (the sum of 3 and 6) gives the quotient 4. Whence 3, 4, 6, are harmonical.

3. To find a third harmonical proportional to two numbers given.

Call one of them the first term, and the other the second: multiply them together, and divide the product by the number remaining after the second is subtracted from double the first; the quotient is a third harmonical proportional: thus, suppose the given terms 3, 4, their product 12 divided by 2 (the remainder after 4 is taken from 6, the double of the first), the quotient is 6, the harmonical third sought.

4. To find a fourth harmonical proportion to three terms given: multiply the first into the third, and divide the product by the number remaining after the middle or second is subtracted from double the first; the quotient is a third harmonical proportion; thus supposing the numbers 9, 12, 16, a fourth will be found by the rule to be 24.

5. If there be four numbers disposed in order, whereof one extreme and the two middle terms are in arithmetical proportion; and the same middle terms with the other extreme are in harmonical proportion, the four are in geometrical proportion; as here $2:3::4:6$, which are geometrical; whereof 2, 3, 4, are arithmetical, and 3, 4, 6, harmonical.

6. If betwixt any two numbers you put an arithmetical mean, and also an harmonical one, the four will be in geometrical proportion: thus betwixt 2 and 6 an arithmetical mean is 4, and an harmonical one 3; and the four $2:3::4:6$, are geometrical.

We have this notable difference between the three kinds of proportion, arithmetical, harmonical, and geometrical; that from any given number we can raise a continued arithmetical series increasing in *infinitum*, but

Proportion not decreasing: the harmonical is decreasable in *infin-*
 || *tum*, but not increasable; the geometrical is both.
Prorefect. **PROPORTION**, or *Rule of Three*. See ARITHMETIC,
 n° 13, 14, 15.

Reciprocal PROPORTION. See RECIPROCAL.

PROPORTION is also used for the relation between unequal things of the same kind, whereby their several parts correspond to each other with an equal augmentation or diminution.

Thus, in reducing a figure into little, or in enlarging it, care is taken to observe an equal diminution or enlargement, through all its parts; so that if one line, *e. gr.* be contracted by one-third of its length, all the rest shall be contracted in the same proportion.

PROPORTION, in architecture, denotes the just magnitude of the members of each part of a building, and the relation of the several parts to the whole; *e. gr.* of the dimensions of a column, &c. with regard to the ordonnance of a whole building.

One of the greatest differences among architects, M. Perrault observes, is in the proportions of the heights of entablatures with respect to the thickness of the columns, to which they are always to be accommodated.

In effect, there is scarce any work, either of the ancients or moderns, wherein this proportion is not different; some entablatures are even near twice as high as others:—yet it is certain this proportion ought of all others to be most regulated; none being of greater importance, as there is none wherein a defect is sooner spied, nor any wherein it is more shocking.

Compass of PROPORTION, a name by which the French, and after them some English, authors call the **SECTOR**.

PROPORTIONAL, relating to proportion. Thus we say, proportional compasses, parts, scales, spirals, &c.

PROPORTIONALS, in geometry, are quantities, either linear or numeral, which bear the same ratio or relation to each other.

PROPOSITION, in logic, part of an argument wherein some quality, either negative or positive, is attributed to a subject.

PROPOSITION, in mathematics, is either some truth advanced and shown to be such by demonstration, or some operation proposed and its solution shown. If the proposition be deduced from several theoretical definitions compared together, it is called a *theorem*; if from a praxis, or series of operations, it is called a *problem*. See the articles **THEOREM** and **PROBLEM**.

PROPOSITION, in oratory. See **ORATORY**, n° 28. 124.

PROPOSITION, in poetry, the first part of a poem, wherein the author proposes briefly, and in general, what he is to say in the body of his work. It should comprehend only the matter of the poem, that is, the action and persons that act. Horace prescribes modesty and simplicity in the proposition, and would not have the poet promise too much, nor raise in the reader too great ideas of what he is going to relate.

PROPREFECT, among the Romans, the prefect's lieutenant, or an officer whom the prefect of the pretorium commissioned to do part of his duty in his place.

PROPRETOR, a Roman magistrate, who, having discharged the office of pretor at home, was sent into a province to command there with his former pretorial authority. It was also an appellation given to those who, without having been pretors at Rome, were sent extraordinarily into the provinces to administer justice with the authority of pretors.

PROPRIETOR, or **PROPRIETARY**, is he who possesses any thing as his own in the utmost degree. Such monks were called *proprietary* as had reserved goods and effects to themselves, notwithstanding their formal renunciation of all at the time of their profession. They are frequently mentioned in the *Monast. Anglic. &c.* and were to be very severely dealt with; to be excommunicated, deprived of burial, &c. *Monachi proprietarii excommunicentur ab abbatibus: et, si in morte proprietarius inventus fuerit, ecclesiastica careat sepultura, &c.* Addit. ad Matt. Par.

PRO RATA, in commerce, a term sometimes used by merchants for *in proportion*; as each person must reap the profit or sustain the loss, *pro rata* to his interest, that is, in proportion to his stock.

PROROGATION, the act of prolonging, adjourning, or putting off, to another time. The difference between a prorogation and an adjournment of parliament is, that by prorogation the session is ended, and such bills as passed in either house, or both houses, and had not the royal assent, must at the next assembly begin again.

PROSCRIPTION, a publication made in the name of the chief or leader of a party, whereby he promises a reward to any one who shall bring him the head of one of his enemies.

Sylla and Marius by turns proscribed each other's adherents.—Under the triumvirate a great part of the best and bravest of the Romans fell by proscription.

The term took its rise from the practice of writing down a list of the persons names, and posting it in public; from *pro* and *scribo* "I write."

PROSE, the natural language of mankind, loose and unconfined by poetical measures, rhymes, &c. In which sense it stands opposed to verse.

There is, however, a species of prose which is measured, such as that in which epitaphs and other inscriptions are generally written; and indeed every man who has formed for himself a style writes in uniform periods regularly recurring. It has been much disputed whether a poem can be written in prose. We enter not into that dispute, as we have said enough on the subject elsewhere. See **NOVEL**.

The word *prose* comes from the Latin *prosa*, which some will have derived from the Hebrew *poras*, which signifies *expendit*: others deduce it from the Latin *pro-rsa*, of *prorsus*, "going forwards;" by way of opposition to *versa*, or "turning backwards," as is necessary in writing.

PROSECUTION, in the criminal law. The next step towards the punishment of offenders after **COMMITMENT**, is their prosecution, or the manner of their formal accusation. And this, in the English law, is either upon a previous finding of the fact by an inquest or grand jury; or without such previous finding.

The former way is either by **PRESENTMENT** or **INDICTMENT**. See these articles.

Propretor
 ||
Prosecution.

Prosecutor
||
Proslambanomene.

The remaining methods of prosecution are without any previous finding by a jury, to fix the authoritative stamp of verisimilitude upon the accusation. One of these, by the common law, was when a thief was taken *with the mainour*, that is, with the thing stolen upon him, *in manu*. For he might, when so detected, *flagrante delicto*, be brought into court, arraigned, and tried, without indictment: as by the Danish law he might be taken and hanged upon the spot without accusation or trial. But this proceeding was taken away by several statutes in the reign of Edward III. though in Scotland a similar process remains to this day. So that the only species of proceeding at the suit of the king, without a previous indictment or presentment by a grand jury, now seems to be that of INFORMATION; which see.

These are all the methods of prosecution at the suit of the king. There yet remains another, which is merely at the suit of the subject, and is called an APPEAL. See that article.

But of all the methods of prosecution, that by indictment is the most general. See INDICTMENT.

PROSECUTOR, in law, he that pursues a cause in another's name.

PROSELYTE, a new convert to some religion or religious sect.

PROSERPINACA, in botany: A genus of the tri-gynia order, belonging to the triandria class of plants; and in the natural method ranking under the 15th order, *Inundate*. The calyx is tripartite superior; there is no corolla; there is one trilocular seed.

PROSERPINE, in fabulous history, the daughter of Jupiter and Ceres, was carried off by Pluto as she was gathering flowers with her companions. Ceres, disconsolate for the loss of her daughter, after having long sought her, heard where she was, and intreated Jupiter to let her return from hell. This request Jupiter granted, on condition she had tasted nothing in Pluto's dominions. Ceres therefore went to fetch her; but when her daughter was preparing to return, Ascalaphus gave information that he had seen Proserpine eat some grains of a pomegranate she had gathered in Pluto's garden; on which she was sentenced to continue in Tartarus in quality of Pluto's spouse, and the queen of those gloomy regions: but to mitigate the grief of Ceres for her disappointment, Jupiter granted that her daughter should only spend six months together in hell with her husband, and the other six on earth with her mother.

Some mythologists imagine that the latter part of the fable alludes to the corn, which must remain all the winter hid in the earth, in order to sprout forth in the spring, and produce the harvest.

PROSEUCHE, in antiquity, properly signifies *prayer*; but it is taken for the places of prayer of the Jews, and was pretty near the same as their synagogues. But the synagogues were originally in the cities, and were covered places: whereas, for the most part, the proseuches were out of the cities, and on the banks of rivers; having no covering, except perhaps the shade of some trees or covered galleries. The word is Greek, *προευχη* *prayer*.

PROSLAMBANOMENE, the name of a musical note in the Greek system.

As the two tetrachords of the Greeks were conjunc-

tive, or, in other words, as the highest note of the first served likewise for the lowest note of the second, it is plain that a complete octave could not be formed. To remedy this deficiency, therefore, one note beneath the lowest tetrachord was added, as an octave to the highest of the last tetrachord. Thus, if we suppose the first to have begun on B, the last must have ended upon A, to which one note subjoined immediately beneath the lowest B in the diatonic order must have formed an octave. This note was called *proslambanomene*. But it appears from authors who have scrutinized antiquity with some diligence, and perhaps with as much success as the data upon which they proceeded could produce, that the names of the notes in the Greek system, which originally signified their natural station in the scale of ascending or descending sounds, were afterwards applied to their positions in the lyre. *Higher* or *lower*, then, according to this application, did not signify their degrees of acuteness or gravity, but their higher or lower situation upon this instrument.

PROSODY, that part of grammar which treats of the quantities and accents of syllables, and the manner of making verses.

The English prosody turns chiefly on two things, numbers and rhyme. See POETRY, n^o 66—76. and Part III.

PROSOPIS, in botany: A genus of the monogynia order, belonging to the decandria class of plants. The calyx is hemispherical and quadridentate; the stigma is simple; the legumen inflated and monospermous.

PROSOPOPEIA, a figure in oratory, whereby we raise qualities of things inanimate into persons. See ORATORY, p. 439 and 452.

PROSTATÆ, in anatomy, a gland, generally supposed to be two separate bodies, though in reality but one, situated just before the neck of the bladder, and surrounding the beginning of the urethra. See ANATOMY, p. 738. col. 2.

PROSTYLE, in architecture, a range of columns in the front of a temple.

PROTAGORAS, a famous Greek philosopher, was born at Abdera. In his youth, his poverty obliged him to submit to the servile office of frequently carrying logs of wood from the neighbouring fields to Abdera. It happened, that as he was one day going on briskly towards the city under one of these loads, he was met by Democritus, who was particularly struck with the neatness and regularity of the bundle. Desiring him to stop and rest himself, Democritus examined more closely the structure of the load, and found that it was put together with mathematical exactness; upon which he asked the youth whether he himself had made it up. Protagoras assured him that he had; and immediately taking it to pieces, with great ease replaced every log in the same exact order as before. Democritus expressed much admiration of his ingenuity; and said to him, "Young man, follow me, and your talents shall be employed upon greater and better things." The youth consented, and Democritus took him home, maintained him at his own expence, and taught him philosophy, which qualified him for the office of legislator of the Thurians. He was more subtle than solid in his reasonings; however, he taught at Athens with great reputation, but was at length

Profody
||
Protagoras.

Burney's
Hist. of
Music,
Dissert.
§ 1.

Enfield's
History of
Philosophy
Vol. I.

Protestis
||
Protector.

length banished from thence for the impiety of his doctrines. He then travelled, and visited the islands in the Mediterranean, where it is said that he was the first philosopher who taught for money. He died in a voyage to Sicily, in a very advanced age. He commonly reasoned by dilemmas, and left the mind in suspense with respect to all the questions he proposed. His moral principles were adopted by Hobbes. (See MORAL PHILOSOPHY). Plato wrote a dialogue against him. He flourished 400 years B. C.

PROTASIS, in the ancient drama, the first part of a comic or tragic piece, wherein the several persons are shown, their characters intimated, and the subject of the piece proposed and entered upon.

It might reach as far as our two first acts; and where it ended the epitasis commenced. See the article EPI-TASIS.

PROTEA, the SILVER-TREE: A genus of the monogynia order, belonging to the tetrandria class of plants; and in the natural method ranking under the 47th order, *Stellate*. There is one quadrifid petal surrounding the germ; there is no proper calyx; the receptacle is palaceous. There are 36 species, all natives of the Cape of Good Hope; of which the most remarkable are, 1. The conifera, with linear, spear-shaped, entire leaves, grows to the height of 10 or 12 feet, with a straight regular stem. The branches naturally form a large regular head. The leaves are long and narrow, of a shining silver colour; and as they remain the whole year, make a fine appearance in the greenhouse. 2. The argentea, commonly called *silver-tree*, has a strong upright stem covered with purplish bark, dividing into several branches which grow erect, garnished with broad, shining, silvery leaves, which make a fine appearance when intermixed with other exotics. Through the whole year it exhibits its glossy white or silvery leaves. It has at first a very uncommon and beautiful appearance, and sometimes in the course of 12 or 15 years reaches the height of 20 feet, which it never exceeds. In a rich soil it grows twice as quick, and is by far the largest of the protea kind. They are generally planted near some firs, and very seldom grow wild; Mr Sparman* thinks it was probably brought to the Cape of Good Hope from *Anamagua*; for he had travelled over the whole north-east side of Hottentot's Holland, without finding it either in its wild state or planted. 3. The nitida, or wageboom, greatly resembles the second sort: the leaves are very silky and white, with erect purple branches.

All these plants, being tender exotics, require to be continually kept in the greenhouse during winter. The first may be propagated by cuttings, which should be cut off in April, just before the plants begin to shoot; the second and third sorts may be propagated by seeds.

PROTECTOR, a person who undertakes to shelter and defend the weak, helpless, and distressed.

Every Catholic nation, and every religious order, has a protector residing at the court of Rome, who is a cardinal, and is called the *cardinal protector*.

Protector is also sometimes used for a regent of a kingdom, made choice of to govern it during the minority of a prince.

Cromwell assumed the title and quality of *lord protector of the commonwealth of England, &c.*

PROTESILAI TURRIS, the sepulchre of Protesilaus, with a temple, at which Alexander sacrificed, (Arian); situated at the south extremity of the Hellespont, next the Chersonesus Thracia. Protesilaus was the first Greek who landed on the coast of Troy, and the first Greek slain by the Trojans, (Homer, Ovid.) His wife Laodamia, to assuage her grief, begged the gods for a sight of his shade; and obtaining her request, she expired in his embraces, (Hyginus.) Protesilaus was also called *Phylacides*, from Phylace, a town of Thessaly.

PROTEST, in law, is a call of witness, or an open affirmation that a person does, either not at all, or but conditionally, yield his consent to any act, or to the proceeding of any judge in a court in which his jurisdiction is doubtful, or to answer upon his oath farther than he is bound by law.

Any of the lords in parliament have a right to protest their dissent to any bill passed by a majority: which protest is entered in form. This is said to be a very ancient privilege. The commons have no right to protest. See PARLIAMENT.

PROTEST, in commerce, a summons written by a notary-public to a merchant, banker, or the like, to accept or discharge a bill of exchange drawn on him, after his having refused either to accept or pay it. See *BILL of Exchange*.

PROTESTANT, a name first given in Germany to those who adhered to the doctrine of Luther; because in 1529 they protested against a decree of the Emperor Charles V. and the diet of Spire; declaring that they appealed to a general council. The same name has also been given to those of the sentiments of Calvin; and is now become a common denomination for all those of the reformed churches.

PROTEUS, in heathen mythology. See EGYPT, n° 6.

PROTHONOTARY, a term which properly signifies *first notary*, and which was anciently the title of the principal notaries of the emperors of Constantinople.

Prothonotary, with us, is used for an officer in the court of king's-bench and common-pleas; the former of which courts has one, and the latter three. The prothonotary of the king's-bench records all civil actions sued in that court, as the clerk of the crown-office does all criminal causes. The prothonotaries of the common pleas enter and enrol all declarations, pleadings, assizes, judgments, and actions: they also make out all judicial writs, except writs of *habeas corpus*, and *disfranchising jurator*, for which there is a particular office, called the *habeas corpora office*: they likewise enter recognizances acknowledged, and all common recoveries; make exemplifications of records, &c.

In the court of Rome there is a college of 12 prelates, called *apostolical prothonotaries*, empowered to receive the last wills of cardinals, to make all informations and proceedings necessary for the canonization of saints, and all such acts as are of great consequence to the Papacy: for which purpose they have the right of admission into all consistories, whether public or half public. They also attend on the pope, whenever he performs any extraordinary ceremony out of Rome.

PROTO, a Greek term, frequently used in composition of priority: thus, proto-collum, in the ancient

Protopogenes jurisprudence, signifies the first leaf of a book; **protomartyr**, the first martyr; **proto-plast**, the first man formed, &c.

PROTOGENES, a celebrated ancient painter, was born at Caunas, a city of Caria, subject to the Rhodians, and flourished 300 years before the birth of our Saviour. He was at first obliged to paint ships for his livelihood; but afterwards acquired the highest reputation for history-painting; though Apelles blamed him for finishing his pieces too highly, and not knowing when to have done. The finest of his pictures was that of Jafus, which is mentioned by several ancient authors, though none of them give any description of it. He worked seven years on this picture; during which time he lived entirely upon lupines and water, being of opinion that this light and simple nourishment left him greater freedom of fancy. Apelles, on seeing this picture, was struck with such admiration, that he was unable to speak, or to find words sufficient to express his idea of its beauty. It was this picture that saved the city of Rhodes when besieged by Demetrius king of Macedon; for being able to attack it only on that side where Protopogenes worked, which he intended to burn, he chose rather to abandon his design than to destroy so fine a piece. Pliny says, that Apelles asking him what price he had for his pictures, and Protopogenes naming an inconsiderable sum, Apelles, concerned at the injustice done to the beauty of his productions, gave him 50 talents, about 10,000*l.* for one picture only, declaring publicly that he would sell it for his own. This generosity made the Rhodians sensible of the merit of Protopogenes; and they were so eager to purchase the picture Apelles had bought, that they paid him a much greater price for it than he had given.

PROTOTYPE, is the original or model after which a thing was formed; but chiefly used for the patterns of things to be engraved, cast, &c.

PROTRACTOR, an instrument for laying down and measuring angles upon paper with accuracy and dispatch; and by which the use of the line of chords is superseded. This instrument is variously formed, as semicircular, rectangular, or circular; and constructed of different materials, as brass, ivory, &c. It is necessary in laying down those surveys or other plans where angles are concerned. For the semicircular protractor, and its use in laying down and measuring angles, see **GEOMETRY**, p. 676. prop. xx. &c.

The rectangular protractor is constructed in form of a right-angled parallelogram, which, when applied to a case of mathematical instruments, is substituted in place of the semicircular protractor and scale of equal parts. Fig. 1. is a representation of it: the manner of using it is exactly similar to that of the semicircular one.

The circular protractor, as its name implies, is a complete circle, and is superior by far to either of the former, both in point of accuracy and dispatch, especially when several angles are to be formed at the same point. The limb of this instrument is divided into 360 degrees, and each degree in some protractors is halved: it has a subdividing scale or vernier, by which an angle may be laid down or measured to a single minute. In the centre of the protractor is a fine mark, which, when an angle is to be protracted or measured,

is to be laid upon the angular point, and 0, or zero on the limb, upon the given line forming one side of the angle.

Fig. 2. represents a circular protractor whose limb is divided as above described, and the dividing scale on the index, which moves round the limb of the protractor on a conical centre, gives every minute of a degree. That part of the index beyond the limb has a steel point fixed at the end, in a direct line with the centre of the protractor, and whose use is to prick off the proposed angles.

Fig. 3. is another circular protractor, a little differently constructed from the former. The central point is formed by the intersection of two lines crossing each other at right angles, which are cut on a piece of glass. The limb is divided into degrees and half degrees, having an index with a vernier graduated to count to a single minute, and is furnished with a tooth and pinion, by means of which the index is moved round by turning a small nut. It has two pointers, one at each end of the index, furnished with springs for keeping them suspended while they are bringing to any angle; and being brought, applying a finger to the top of the pointer, and pressing it down, pricks off the angle. There is this advantage in having two pointers, that all the bearings round a circuit may be laid or pricked off, although the index traverses but one half of the protractor.

Another circular protractor, different from either of the former, is represented at fig. 4. The centre is also formed by the intersection of two lines at right angles to each other, which are cut on glass, that all parallax may thereby be avoided. The index is moved round by a tooth and pinion. The limb is divided into degrees and half degrees, and subdivided to every minute by the vernier. The pointer may be set at any convenient distance from the centre, as the socket which carries it moves upon the bar BC, and is fixed thereto by the nut D, at right angles to the bar BC, and moveable with it. There is another bar EF: On this bar different scales of equal parts are placed; so that by moving a square against the inner edge thereof, angles may be transferred to any distance within the limits, from the centre containing the same number of degrees marked out by the index.

It would indeed be superfluous to describe any more of these circular protractors, especially as the little alterations in them depend very much upon the fancy of the artist. Suffice it however to say, that we have seen others still differently constructed, one of which we shall briefly describe. The divisions upon the limb of this instrument are similar to those already described; but the index is a straight bar continued to some considerable distance each way beyond the limb of the instrument, and has a vernier to show minutes as usual; a mark upon one of the edges of the index always coincides with the centre of the instrument. Instead, therefore, of pricking down the angle as in the former, part of the line containing the angle may be drawn, which, although perhaps not so accurate as a point, is more conspicuous, and the line is easily completed upon removal of the protractor. The common dimensions of the circular part of these instruments is from six to ten inches diameter; and they are made of brass.

PROTUBERANCE,

Protuberance
||
Providence

PROTUBERANCE, in anatomy, is any eminence, whether natural or preternatural, that projects or advances out beyond the rest.

PROVEDITOR, an officer in several parts of Italy, particularly at Venice, who has the direction of matters relating to policy.

PROVENCE, a province or government of France, bounded by Dauphine on the north, by Piedmont on the east, by the Mediterranean on the south, and by the river Rhone, which separates it from Languedoc, on the west: it is about 100 miles long, and near as many broad.

PROVEND, or **PROVENDER**, originally signified a kind of vessel containing the measure of corn daily given to a horse, or other beast of labour, for his subsistence; but is now generally used to signify the food for cattle, whatever it is.

PROVERB, according to Camden, is a concise, witty, and wise speech, grounded upon experience, and for the most part containing some useful instruction.

Book of PROVERBS, a canonical book of the Old Testament, containing a part of the proverbs of Solomon the son of David king of Israel. The first 24 chapters are acknowledged to be the genuine work of that prince; the next five chapters are a collection of several of his proverbs made by order of king Hezekiah; and the two last seem to have been added, though belonging to different and unknown authors, Agur the son of Jakeh, and king Lemuel.

In this excellent book are contained rules for the conduct of all conditions of life; for kings, courtiers, masters, servants, fathers, mothers, children, &c.

PROVIDENCE, the superintendence and care which God exercises over creation.

That there exists a divine providence which attends to the affairs of this world, and directs their course, has been a received opinion among the human race in every country and in every period of history. Every altar that is erected, every prayer and every sacrifice that is offered up, affords a proof of this belief. So fully have men been convinced of the sincerity of each other's faith upon this subject, that in one form, that of an appeal to the Divine Ruler of the world, by the solemnity of an oath, they have introduced it both into the most ordinary and the most important business of life.

This universal conviction of men of all degrees of knowledge, from the most profound philosopher to the rudest barbarian, is probably to be traced to some primordial tradition, never totally effaced from any nation under heaven. The truth itself, however, is susceptible of the most complete proof from principles of science. If the world had a beginning, it may obviously have an end, and can be continued in existence only by the constant energy of that power by which it was at first created. He therefore who acknowledges a creation and denies a providence, involves himself in this palpable contradiction—"that a system, which of itself had not an original and momentary existence, may yet of itself have a perpetual existence; or that a being which cannot of itself exist for a second of time, may yet, of itself, exist for thousands of years!" Or should we be so complaisant, as for a moment to suppose, with certain theists, ancient and modern, that the *matter* of the universe is self-existent and eternal, and that the power of

God was exerted, not in creating substances, but in reducing the original matter from a state of chaos into that beautiful order in which we see it arranged; the constant energy of providence must still be admitted as necessary to preserve the forms and to continue the motions which were originally impressed upon the chaotic mass. From late experiments it appears extremely doubtful whether any two atoms of the most solid body be in actual contact; and that they are not *all* in contact is certain. (See *METAPHYSICS*, n° 176. and *OPTICS*, n° 46, 64, 66.) Yet it requires a very considerable degree of force to carry to a greater distance from one another the parts of a stone or of a bar of iron. By what power then are these parts kept contiguous? It cannot be by their own; because nothing can act where it is not present, and because our best philosophy has long taught us that the atoms of matter are essentially inactive. Again, it requires a very great degree of force to bring two bodies, however small, into *apparent* contact (see *OPTICS*, *ubi supra*); and therefore it follows that they must be kept asunder by some foreign power. Every attempt to solve these phenomena by the intervention of a subtle fluid is vain; for the question recurs, what keeps the parts of the fluid itself contiguous, and yet separated from each other?

The cohesion therefore of the parts of matter, and that which is called their repulsive power, demonstrate, through the whole system, the immediate energy of something which is not matter, and by which every body small and great is preserved in its proper form. It has been elsewhere shown (see *METAPHYSICS*, Part II. chap. 5. and *MOTION*, n° 19, 20.), that the various motions which are regularly carried on through the universe, by which animals and vegetables grow and decay, and by which we have day and night, summer and winter, cannot be accounted for by any laws of mere mechanism, but necessarily imply the constant agency of something which is itself distinct from matter. But the forms of bodies are preserved, and their natural motions carried on, for purposes obviously planned by Wisdom. The power therefore which effects these things must be combined with intelligence: but power and intelligence preserving the order of the universe constitute all that is meant by a general providence; which is therefore as certainly administered as the sun daily rises and sets, or as bodies are kept solid by what is termed cohesion and repulsion.

Abstracted and metaphysical as this reasoning may appear, it is by no means peculiar to the philosophers of Europe. Its force has been felt from time immemorial by the Bramins of Hindostan, who, as Sir William Jones informs us*, "being unable to form a distinct idea of brute matter independent of mind, or to conceive that the work of supreme goodness was left a moment to itself, imagine that the Deity is ever present to his work, not in substance but in spirit and in energy." On this rational and sublime conception they have indeed built numberless absurd superstitions; but their holding the opinion itself, shows that they believe in the reality of providence upon philosophical principles: and what truth is there on which the mind of man has not ingrafted marks of its own weakness?

Few nations, however, except the ancient Greeks, have had philosophers equally subtle with the Bramins

1
Definition.

2
Belief of a providence universal.

3
Existence of providence may be proved on scientific principles.

4
Reasoning of the Bramins of Hindostan.

* Asiatic Researches, Vol. I.

Providence of India; and therefore though all mankind have in general agreed in the belief of a superintending Providence, they have in different ages and countries admitted that truth upon different kinds of evidence, and formed very different notions concerning the mode in which the Divine superintendence is exerted.

5
idea of pro-
vidence in
use ages.

While societies are still in a rude and unpolished state, while individuals possess little security and little leisure for the exertion of their rational powers, every important or singular appearance in nature becomes an object of wonder or of terror. In this state of ignorance, men see not the universe as it is, a great collection of connected parts, all contributing to form one grand and beautiful system. Every appearance seems to stand alone; they know that it must have a cause, but what that cause is they are ignorant. The phenomena exhibited by nature are so complicated and so various, that it never occurs to them that it is possible for one Being to govern the whole. Hence arose the different systems of polytheism that have appeared in the world. Nature was divided into different regions, and a particular invisible power was assigned to each department: one conducted the flaming chariot of the sun, another wielded the terrible thunderbolt, and others were employed in diffusing plenty, and introducing the useful arts among men. Thus, although the various systems of polytheism in general acknowledged one Supreme Ruler, the father of gods and men, yet they at the same time peopled not only the regions above, the air and the heavens, but they also filled the ocean and the land, every grove, and every mountain, with active but invisible natures. Having arisen from the same causes, these systems of polytheism, which are so many hypotheses concerning Divine providence, are all extremely similar; and we have a very favourable specimen of them in the elegant mythology of Greece and Rome, which gave to every region of nature a guardian genius, and taught men in the deep recesses of the forest, or in the windings of the majestic flood, to expect the presence of protecting and friendly powers. See POLYTHEISM.

6
The doctrine has had opponents in almost every age.

Notwithstanding this universal reception, in some form or other, of the doctrine of a divine providence, it has in every age met with some opponents. The most ancient of these were Democritus and Leucippus. They denied the existence of a Deity—asserted that all things were mechanically necessary, and that thought and sense were only modifications of matter. This is atheism in the strictest sense, and the only form of it that has ever been consistently supported. Epicurus followed upon the same principles; but he rendered the system altogether absurd, by confessing the freedom of the human will. To avoid the imputation of atheism, he asserted the existence of God; but declared that he resided above the heavens, and interfered not in human affairs. One of his maxims was, that “the blessed and immortal Being neither hath any employment himself, nor troubles himself with others.” Maximus Tyrius* justly observes, that this is rather a description of a Sardanapalus than of a Deity. And some of the moralists† of antiquity remarked, that they knew many men among themselves possessed of active and generous minds, whose characters they valued more highly than that of Epicurus’s god. Some of the ancients also appear to have entertained the following strange notion: They acknowledged the existence of a Supreme and of

* Max. Tyr. Dissert. 29.
† Cicero de finibus, lib. 1. and De Natura Deorum, lib. 2.

many inferior deities; but at the same time, they supposed that there is a certain fate which rules over all, and is superior to the gods themselves. See NECESSITY in Mythology.

The providence exerted by the Author of nature over his works is usually divided into two branches: a general, referring to the management of the universe at large; and a particular providence, chiefly regarding particular men.

Upon the first of these, in *The Religion of Nature delineated*, the question is stated somewhat in the following manner: The world may be said to be governed, or at least cannot be said to fluctuate fortuitously, if there are laws or rules by which natural causes act; if the several phenomena in it succeed regularly, and in general the constitution of things is preserved; if there are rules observed in the production of herbs, trees, and the like; if the several kinds of animals are furnished with faculties proper to determine their actions in the different stations which they hold in the general economy of the world; and, lastly, if rational beings are taken care of in such a manner as will at last agree best with reason. By the providence of God we ought to understand his governing the world by such laws as these now mentioned: so that if there are such, there must be a Divine providence.

With regard to *inanimate objects*, the case agrees precisely with the above supposition. The whole of that universe which we see around us is one magnificent and well regulated machine. The world that we inhabit is a large globe, which, conducted by an invisible power, flies with a rapidity of which we have no conception, through an extent of space which sets at defiance every power of fancy to embody it into any distinct image. A large flaming orb stands immovable in the heavens; around which this, and other worlds of different magnitudes, perform their perpetual revolutions. Hence arise the expected returns of day and night, and the regular diversity of seasons. Upon these great operations a thousand other circumstances depend. Hence, for example, the vapours ascend from the ocean, meet above in clouds, and after being condensed, descend in showers to cover the earth with fertility and beauty. These appearances are permanent and regular. From every age since men have been placed upon the earth, this astonishing machine continued steadily to perform its complicated operations. Nothing is left to chance. The smallest bodies are not less regular than the largest, and observe continually the same rules of attraction, repulsion, &c. The apparent variations of nature proceed only from different circumstances and combinations of things, acting all the while under their ancient laws. We ourselves can calculate the effects of the laws of gravitation and of motion. We can render them subservient to our own purposes, with entire certainty of success if we only adhere to the rules established by nature, that is to say, by providence.

Vegetables also live and flourish according to prescribed methods. Each sort is produced from its proper seed; has the same texture of fibres, is at all times nourished by the same kind of juices, digested and prepared by the same vessels. Trees and shrubs receive annually their peculiar liveries, and bear their proper fruits: so regular are they in this last respect, that every species may be said to have its profession or trade ap-

Providence pointed to it, by which it furnishes a certain portion of manufacture, or of food, to supply the wants of animals: being created for the purpose of consumption, all vegetables produce great quantities of feed to supply the necessary waste. Here too, then, there is evidently a *regulation* by which the several orders are preserved, and the ends of them answered according to their first establishment.

10
Animals,

With regard to *animals*, they too, in structure of their form, are subject to laws similar to those which govern the vegetable world. In the sentient part of their constitution they are no less subject to rule. The lion is always fierce, the fox is crafty, and the hare is timid. Every species retains from age to age its appointed place and character in the great family of nature. The various tribes are made and placed in such a manner as to find proper means of support and defence. Beasts, birds, fishes, and insects, are all possessed of organs and faculties adapted to their respective circumstances, and opportunities of finding their proper food and prey.

11
And man.

Man is subject to the ordinary laws which other material and animal substances obey; but he is left more at large in the determination of his actions. Yet even here things do not fluctuate at random. Individuals do indeed rise and perish according to fixed rules, and nations themselves have only a temporary endurance. But the species advances with a steady progress to intellectual improvement. This progress is often interrupted; but it appears not to be less sure at the long-run than even the mechanical laws which govern the material part of our constitution. Amidst the convulsion of states and the ruin of empires, the useful arts, when once invented, are never lost. These, in better times, render subsistence easy, and give leisure for reflection and study to a greater number of individuals. Tyre and Sidon have passed away, Athens itself has become the prey of barbarians, and the prosperity of ancient Egypt is departed, perhaps for ever; but the ship, the plow, and the loom, remain, and have been perpetually improving. Thus every new convulsion of society does less mischief than the last; and it is hoped that by the assistance of printing the most polished arts and the most refined speculations have now become immortal.

The world is not then left in a state of confusion: it is reduced into order, and methodised for ages to come; the several species of beings having their offices and provinces assigned them. Plants, animals, men, and nations, are in a state of continual change; but successors are appointed to relieve them, and to carry on the *scheme of Providence*.

12
Difficulty of accounting for particular providence.

But the great difficulty is, how to account for that providence which is called *particular*: For rational beings, and free agents, are capable of doing and deserving well or ill; and the safety or danger, that happiness or unhappiness, of a man here, must depend upon many things that seem scarcely *capable* of being determined by Providence. Besides *himself* and his own conduct, he depends upon the conduct of *other men*; whose actions, as we naturally suppose, cannot, consistently with their free will, be controuled for the advantage of another individual. The actions of numbers of men proceeding upon their private freedom, with different degrees of ability, as they cross and impede, or directly

oppose each other, must produce very different effects upon men of different characters, and thus in a strange manner embarrass and entangle the general plan. And as to the *course of nature*, it may justly be asked, is the force of gravitation to be suspended till a good man pass by an infirm building? (See PRAYER) Add to this, that some circumstances appear absolutely irreconcilable. The wind which carries one into port drives another back to sea; and the rains that are just sufficient upon the hills may drown the inhabitants of the valleys. In short, may we expect *miracles*? or can there be a particular Providence that foresees and prepares for the several cases of individuals, without force frequently committed upon the laws of nature and the freedom of intelligent agents?

In whatever way it is brought about, there is little doubt that something of this kind *must* take place. For as the Deity *does* direct, as already mentioned, the great and general progress of things in this world, he must also manage those of less importance. Nations are composed of individuals. The progress of individuals is the progress of the nation, and the greatest events usually depend upon the history and the most trifling actions of private persons. The difficulty is to conceive how the superintendence and management of all this can be brought about. But as the ways and the thoughts of the Omnipotent Spirit, whose influence pervades, and rules, and animates nature, resemble not the limited operations of men, we can only form conjectures concerning the means by which his government is conducted.

1. In the first place, then, it is not impossible that the Deity should foresee the future actions of intelligent beings. Many of these actions depend upon the mechanism of the material world, which was formed by himself, and must be entirely known to him. Many men among ourselves possess much sagacity in discerning the future actions of others, from attending to their known characters, and the circumstances in which they are placed. If superior natures do exist, and minds more perfect than the human, they must possess this penetration in a more eminent degree in proportion to the excellence of their intellectual powers. But if this discernment be in God proportionable to his nature, as in lower beings it is proportionable to theirs, it then becomes altogether unlimited, and the future actions of free agents are at once unlocked and exposed to his view. Add to this, that the Author of nature is well acquainted with the creatures that he has made; he knows the mechanism of our bodies, the nature and extent of our understandings, and all the circumstances by which we are surrounded. With all these advantages, it is making no great stretch to suppose him capable of discerning the line of conduct which we will pursue; and this even setting aside the infinity of his nature, to which a thousand years are as one day, and supposing him to reason from probabilities in the imperfect manner that we do.

2. There is no impossibility at least, that men, whose characters and actions are thus foreknown, may be introduced into the world in such times and places as that their acts and behaviour may not only coincide with the general plan of things, but may also answer many private cases. The celestial bodies are so placed that their jarring attractions make out a splendid system.

Why

13
No good argument against its existence.

14
The Deity may easily foresee the actions of men;

15
And may thence fit them for their situations in life.

Providence Why then may there not be in the Divine mind something like a projection of the future history of mankind, as well as of the motions of the heavenly bodies? And why should it not be thought possible for men, as well as for them, by some secret law, or rather by the management of an unseen power, to be brought into their places in such a manner as that; by the free use of their faculties, the conjunctions and oppositions of their interests and inclinations, the natural influence of their different degrees of talents, power, and wealth, they may conspire to make out the great scheme of human affairs? There is no absurdity in this supposition: it is not beyond the power of an almighty and perfect Being; and it is worthy of him. Let us take from the Jewish history, as most generally known, an example of what may be supposed to happen daily. It was the intention of providence to place David the son of Jesse upon the throne of the Hebrews. The country is invaded by a foreign enemy: the hostile armies meet, and lie encamped upon opposite mountains. A man comes forth from the army of the invaders, as was extremely common in those times, and defies the Hebrew host to send forth a champion to meet him in single combat. Terried by the gigantic bulk and mighty force of Goliath, no man would risk the unequal conflict. David, who was too young to carry arms, had been sent to the camp with provisions for his brothers, and heard the challenge. In defence of his flock he had killed some beasts of prey in the wilderness, and he was an excellent marksman with the sling. He thought it might probably be as easy to kill a man as a wild beast; at all events, he knew that a stone well directed would prove no less fatal to a giant than to a dwarf: he therefore resolved to try his skill; and he tried it with success. Here no man's free will was interrupted, and no miracle was accomplished: Yet by this *train* of circumstances thus brought together, a foundation was laid for the future fortunes of the son of Jesse, for the greatness of his country, and for accomplishing the purposes of Providence. According to Seneca, "*Hoc dico, fulmina non mitti a Jove, sed sic omnia disposita, ut ea etiam quæ ab illo non fiunt, tamen sine ratione non fiunt: quæ illius est. — Nam et si Jupiter illa nunc non facit, fecit ut fierent.*"—*I say, that the lightning comes not directly from the hand of Jove, but things are properly disposed for the indirect execution of his will; for he acts not immediately, but by the intervention of means.*

16
The possibility of his exemplified.

17
Secret influences on the mind are far from impossible.

3. Lastly, it is not impossible that many things may be accomplished by secret influence, upon the human mind, either by the Deity himself, or by the intervention of agents possessed of powers superior to those which belong to us. "For instance, if the case should require that a particular man be delivered from some threatening ruin, or from some misfortune, which would certainly befall him if he should go such a way at such a time, as he intended: upon this occasion some new reasons may be presented to his mind why he should not go at all, or not then, or not by that road; or he may forget

to go. Or, if he is to be delivered from some danger. **Providence** *ous enemy*, either some new turn given to his thoughts may divert him from going where the *enemy* will be, or the enemy may be after the same manner diverted from coming where *he* shall be, or his resentment may be qualified; or some proper method of defence may be suggested to the person in danger. After the same manner advantages and successes may be conferred on the deserving; as, on the other side, men, by way of punishment for their crimes, may incur mischiefs and calamities. These things, and such as these (says Mr Wollaston*), may be. For since the motions and actions of men, which depend upon their wills, do also depend upon their judgments, as these again do upon the *present appearances* of things in their minds; if a new prospect of things can be any way produced, the lights by which they are seen *altered*, new forces and directions impressed upon the spirits, passions *exalted* or *abated*, the power of judging *enlivened* or *debilitated*, or the attention taken off without any suspension or alteration of the standing laws of nature,—then, without that, *new* volitions, designs, measures, or a cessation of thinking, may also be produced; and thus many things prevented that otherwise would be, and many brought about that would not. That there may possibly be such inspirations of new thoughts and counsels (continues our author), may perhaps appear farther from this, that we frequently find thoughts arising in our heads, into which we are led by no discourse, nothing we read, no clue of reasoning, but they surprise and come upon us from we know not what quarter. If they proceeded from the mobility of spirits straggling out of order, and fortuitous affections of the brain, or were they of the nature of *dreams*, why are they not as wild, incoherent, and extravagant as they are?" Is it not much more reasonable to imagine that they come by the order and direction of an all-seeing and all-gracious God, who continually watches over us, and disposes every thing in and about us for the good of ourselves or others? not to speak of the agreeableness of this notion to the opinions of the best and wisest men in all ages (A). "If this, then, be the case, as it seems to be, that mens minds are susceptible of such *insinuations* and *impressions*, as frequently, by ways unknown, do affect them, and give them an inclination towards this or that; how many things (asks our author) may be brought to pass by these means without fixing and refining the laws of nature, any more than they are unfixed when one man alters the opinion of another by throwing in his way a book proper for that purpose?"

All this may be effected either by the immediate interposition of God himself, or by that of beings *invisible*, and in nature superior to us, who act as the ministers of his providence. That there are such beings we can hardly doubt, as it is in the highest degree improbable that such imperfect beings as men are at the top of the scale of created existence. And since we ourselves, by the use of our limited powers, do often alter the course

4 H 2

of

(A) That such was the general belief of the Greeks in the days of Homer, is plain from that poet's constantly introducing his deities into the narrative of his poems, and telling us that Minerva, or some other god, altered the minds of his heroes. "By this," says Plutarch, "the poet does not mean to make God *desire* the will of man, but only move him to will: nor does he miraculously produce the appetites themselves in men, but only cause such imaginations as are capable of exciting them."

* Religion of Nature delineated, sect. 5.

Providence of things within our sphere from what they would be if left to the ordinary laws of motion and gravitation, without being said to alter those laws; why may not superior beings do the same as instruments of divine providence? This idea of the intervention of superior natures is beautifully illustrated by Thomson in the following passage:

These are the haunts of meditation, these
The scenes where ancient bards th'inspiring breath,
Ecstatic, felt; and from this world retir'd,
Convers'd with angels and immortal forms,
On gracious errands bent: to save the fall
Of virtue struggling on the brink of vice;
In waking whispers, and repeated dreams,
To hint pure thought, and warn the favour'd soul
For future trials fated to prepare.

We agree, however, with Mr Wollaston, in thinking the power of these beings not so large as to alter or suspend the general laws of nature (see MIRACLE); for the world is not like a bungling piece of clock-work, which requires to be often set backwards or forwards. We are likewise perfectly satisfied, that they cannot change their condition, to ape us or inferior beings; and consequently we are not apt hastily to credit stories of *portents*, &c. such as cannot be true, unless the nature of things and their manner of existence were occasionally reversed. Yet as men may be so placed as to become, even by the free exercise of their own powers, *instruments* of God's particular providence to other men; so may we well suppose that these higher beings may be so distributed through the universe, and subject to such an economy, unknown to us, as may render *them also* instruments of the same providence; and that they may, in proportion to their greater abilities, be capable, *consistently with the laws of nature*, of influencing human affairs in proper places.

19
Objections
to the doc-
trine of
Providence

20
From the
imperfec-
tions of na-
ture,

We shall next proceed to state some of the chief objections which in ancient or modern times have been brought against the opinion, that the world is governed by a Divine providence.

1. The first of these is this, that the system of nature contains many imperfections which it ought not to do if it be the work of a perfectly wise and good Being. To avoid the force of this objection, some modern writers have deserted the ground of supreme and absolute goodness, which the ancient theists always occupied, and have asserted that the divine perfection consists in unlimited power and uncontrolled supremacy of will; that consequently the Deity does not always that which is best, but merely what he himself pleases; and that for no other reason but because he *wills* to do so. But this is no better than atheism itself. For it is of no importance to us whether the universe is governed by blind fate or chance, that is to say, by nothing at all; or whether it is governed by an arbitrary sovereign will that is directed by chance, or at least by no principle of beneficence.

21
Answered.

The true answer to this objection is, that no created system can have every perfection, because it must necessarily be destitute of self-existence and independence; and therefore if beings destitute of some perfections be better than nothing, it was worthy of infinite power and perfect goodness to create such beings. In our present

state, we mortals stand upon too low ground to take a **Providence** commanding view of the whole frame of things. We can only reason concerning what is unknown from the little that is within our reach. In that little, we can see that wisdom and goodness reign; that nature always aims to produce perfection; that many salutary effects result even from the thunder and the storm: and we doubt not that a view of the whole structure of the universe would afford an additional triumph to the goodness and skill of its great Architect.

We see a regular ascent in the scale of beings from mere lifeless matter up to man; and the probability is, that the scale continues to ascend as far above man in perfection as created beings can possibly be raised.—The sole purpose of God in creating the world must have been to produce happiness: but this would be most effectually done by creating, in the first place, as many of the most perfect class of beings as the system could contain; and afterwards other classes less and less perfect, till the whole universe should be completely full. We do not positively assert such a scheme of creation,

Where all must full, or not coherent be;
And all that rises, rise in due degree,

was actually in the divine Architect's intention; but that it is possible, is sufficiently obvious. No man will pretend to say, that this earth could afford a comfortable subsistence to a greater number of the human race, were all the inferior animals annihilated, than it could at present, swarming as every element is with life.—Suppose then, that as many men had been placed at first upon the earth as it could possibly support, and that matters had been so constituted, as that the number should never have been either increased or diminished; we beg leave to ask, whether, since there would have been evidently room for inferior animals, it would have been most worthy of infinite goodness to leave the whole globe to men, or to introduce into it different orders of less perfect beings, which, while they could not incommode this principal inhabitant, would each find pleasure in its own existence? To this question different answers cannot surely be given. Let the reader then extend his view, and consider the universe, which, however vast, cannot be positively infinite, as one system as much united as the several parts of this globe; let him suppose that there were at first created as many of the highest order of beings as it could have contained had creation there stopt; let him remember that happiness in many different degrees is valuable;—and he will not surely think it any imputation on the goodness of God that there are in the universe many beings far from perfection. The most imperfect of these are by themselves better than nothing; and they all contribute to make up a system which, considered as a whole, we have every reason to believe to be as perfect as any thing not self-existent can possibly be.

2. If the world is conducted by a benevolent provi-
dence, how came evil to be introduced into it? This ²² Objection from the question has perplexed mankind in all ages. The an-introduc-
cient Persians resolved it, by asserting the existence of tion of evil,
two gods, Oromasdes the author of good, and Arima-
nius the author of evil. From them the Christian he-
retics called *Manichees* borrowed their doctrine of two

Providence opposite co-eternal principles. Both the Platonists and Stoics ascribed the origin of evil to the perverseness or imperfection of matter, which they thought the Deity could not alter; and Pythagoras imagined a state of pre-existence, in which the souls of men had committed offences, for which they are here suffering the punishment. But these hypotheses are, some of them impious, and all unsatisfactory.

23
Answered.

Taking the expression in its most extensive sense, the evils to which the human race are exposed may be reduced to *pain, uneasiness, disappointment of appetites, and death*; of which not one could have been wholly prevented without occasioning greater evils, inconsistent with the perfect goodness of the Creator. As long as we have solid bodies capable of motion, supported by food, subject to the influence of the atmosphere, and divisible, they must necessarily be liable to dissolution or death: But if a man could suffer death, or have his limbs broken, without feeling pain, the human race had been long ago extinct. A fever is a state of the body in which the fluids are in great disorder. Felt we no uneasiness from that disorder, we should have no inducement to pay the proper attention to our state, and should certainly die unawares, without suspecting ourselves to be in danger; whereas, under the present administration of divine providence, the pain and sickness of the disease compel us to have recourse to the remedies proper for restoring us to soundness and to health. Of the uneasinesses to which we are liable, and which are not the effect of immediate pain, the greatest has been sometimes said to arise from the apprehension of death, which constantly stares us in the face, and frequently embitters all our pleasures even in the hour of perfect health.—But this dread of death is implanted in our breasts for the very best of purposes. Had we no horror at the apprehension of death, we should be apt, whenever any misfortune befel us, to quit this world rashly, and rush unprepared into the presence of our Judge: but the horror which attends our reflections on our own dissolution, arising not from any apprehensions of the pain of dying, but from our anxiety concerning our future state of existence, tends strongly to make us act, while we are here, in such a manner as to ensure our happiness hereafter. Add to this, that the fear of death is the greatest support of human laws. We every day see persons breaking through all the regulations of society and good life, notwithstanding they know death to be the certain consequence, and feel all the horrors of it that are natural to man: and therefore were death divested of these horrors, how insignificant would capital punishments be as guardians of the law, and how insecure would individuals be in civil society?

With regard to the unavoidable misfortunes and anxieties of our present state, so far from being truly hurtful in themselves, they are proofs of divine beneficence. When we see men displeased with their situation, when we hear them complain of the difficulties, the miseries, and the cares of life, of the hardships which they have undergone, and the labours which still lie before them; instead of accounting them unfortunate, we ought to regard them as active beings, placed in the only situation that is fit for the improvement of their nature. That discontent, these restless wishes to improve their condition, are so many sure indications that their faculties will not languish. They who are in the least de-

gree accustomed to observe the human character, know well the influence which pleasure and repose have in enfeebling every manly principle, and how capable they are of attaching us even to a sordid and dishonourable existence.

Happy indeed it is for the human race, that the number of those men is small whom providence has placed in situations in which personal activity is unnecessary. By far the greater number are compelled to exert themselves, to mix and to contend with their equals, in the race of fortune and of honour. It is thus that our powers are called forth, and that our nature reaches its highest perfection. It is even perhaps a general truth, that they who have struggled with the greatest variety of hardships, as they always acquire the highest energy of character, so if they have retained their integrity, and have not sunk entirely in the contest, seldom fail to spend their remaining days respectable and happy, superior to passion, and secured from folly by the possession of a wisdom dearly earned.

But the benefits of physical evils have been set in a still stronger light by a great master of moral wisdom, who was himself subject to many of those evils. That man is a moral agent, sent into this world to acquire habits of virtue and piety to fit him for a better state, is a truth to which no consistent thief will for a moment refuse his assent. But almost all the moral good which is left among us, is the apparent effect of physical evil.

“Goodness is divided by divines into soberness, righteousness, and godliness. Let it be examined how each of these duties would be practised if there were no physical evil to enforce it.” *Johnson's Idler. n^o 89.*

“Sobriety or temperance is nothing but the forbearance of pleasure; and if pleasure was not followed by pain, who would forbear it? We see every hour those in whom the desire of present indulgence overpowers all sense of past, and all foresight of future misery. In a remission of the gout, the drunkard returns to his wine, and the glutton to his feast; and if neither disease nor poverty were felt or dreaded, every one would sink down in idle sensuality, without any care of others, or of himself. To eat and drink, and lie down to sleep, would be the whole business of mankind.

“Righteousness, or the system of social duty, may be subdivided into justice and charity. Of justice, one of the heathen sages has shown, with great acuteness, that it was impressed upon mankind only by the inconveniences which injustice had produced. ‘In the first ages (says he) men acted without any rule but the impulse of desire; they practised injustice upon others, and suffered it from others in their turn: but in time it was discovered, that the pain of suffering wrong was greater than the pleasure of doing it; and mankind, by a general compact, submitted to the restraint of laws, and resigned the pleasure to escape the pain.’”

“Of charity, it is superfluous to observe, that it could have no place if there were no want; for of a virtue which could not be practised, the omission could not be culpable. Evil is not only the occasional but the efficient cause of charity; we are incited to the relief of misery by the consciousness that we have the same nature with the sufferer; that we are in danger of the same distresses, and may some time implore the same assistance.

“Godliness

Providence

Providence

"Godliness or piety is elevation of the mind towards the Supreme Being, and extension of the thoughts of another life. The other life is future, and the Supreme Being is invisible. None would have recourse to an invisible power, but that all other subjects had eluded their hopes. None would fix their attention upon the future, but that they are discontented with the present. If the senses were feasted with perpetual pleasure, they would always keep the mind in subjection. Reason has no authority over us but by its power to warn us against evil.

"In childhood, while our minds are yet unoccupied, religion is impressed upon them; and the first years of almost all who have been well educated are passed in a regular discharge of the duties of piety: But as we advance forward into the crowds of life, innumerable delights solicit our inclinations, and innumerable cares distract our attention. The time of youth is passed in noisy frolics; manhood is led on from hope to hope, and from project to project; the dissoluteness of pleasure, the inebriation of success, the ardour of expectation, and the vehemence of competition, chain down the mind alike to the present scene: nor is it remembered how soon this mist of trifles must be scattered, and the bubbles that float upon the rivulet of life be lost for ever in the gulph of eternity. To this consideration scarce any man is awakened but by some pressing and resistless evil; the death of those from whom he derived his pleasures, or to whom he destined his possessions, some disease which shows him the vanity of all external acquisitions, or the gloom of age which intercepts his prospects of long enjoyment, forces him to fix his hopes upon another state; and when he has contended with the tempests of life till his strength fails him, he flies at last to the shelter of religion.

"That misery does not make all virtuous, experience too certainly informs us; but it is no less certain, that of what virtue there is, misery produces far the greater part. Physical evil may be therefore endured with patience, since it is the cause of moral good; and patience itself is one virtue by which we are prepared for that state in which evil shall be no more."

25
Objection
from the
permission
of moral
guilt,

The calamities and the hardships of our present state, then, are so far from being real evils, of which providence ought to be accused, that in every point of view in which we can consider them, they afford the surest proofs of the wisdom of its administration, and of its goodness to man.

The most serious difficulty lies in accounting for the permission of moral evil or guilt, in a system governed by infinite benevolence and wisdom. Those who in a consistent manner hold the doctrine of the absolute necessity of human actions in its full extent, and acknowledge all its consequences, find it easy to elude this difficulty. They very fairly deny the existence of any such thing as moral evil in the abstract; and assert, that what we call a *crime*, is nothing more than an action which we always regard with a painful sensation: that these apparent evils endure only for a time; and that all will at last terminate in the perfection and happiness of every intelligent being.

26
Answered.

Upon the system of liberty, the shortest answer seems to be this: that some things are absolutely impossible, not from any weakness in the Deity, but because they infer absurdity or contradiction. Thus it is impossible

for twice two to be any thing else than four; and thus it is impossible for Omnipotence itself to confer self-approbation upon an intelligent being who has never deserved it; that is to say, it is impossible for a man of sense to be pleased with himself for having done a certain action, while he himself is conscious that he never did that action. But self-approbation constitutes the highest, the most unmingled, and permanent felicity, of which our nature is capable. It is not in the power of Omnipotence itself, then, to bestow the highest and most permanent felicity of our nature; it must be *earned* and deserved before it can be obtained. In the same manner good desert, virtue or merit, cannot be *conferred*; they must be *acquired*. To enable us to acquire these, we must be exposed to difficulties, and must suffer in a certain degree. If these difficulties had no influence upon our conduct and feelings, if they exposed us to no real danger, no fabric of merit and of self-approbation could be reared upon them. All that the Supreme Being could do for us, was to confer such an original constitution and character as would enable us to do well if we should exert our utmost powers. The universe is not ruled by favour, but by justice. Complete felicity must be purchased. Guilt is an abuse of our freedom, a doing ill where we could have done well, and is entirely the work of man. Heaven could not avoid permitting its existence, and exposing us to danger; for temptation is necessary to virtue, and virtue is the perfection of our nature, our glory, and our happiness.

The permission of moral evil has been so ably accounted for by Simplicius, a Pagan writer, and therefore not biased by any partiality to the Jewish or Christian Scriptures, that we cannot deny ourselves the pleasure of laying his reasoning before our readers. He asks*, "Whether God may be called the author of sin, because he permits the soul to use her liberty? and answers the question thus:

27
By Simplicius.

"He who says that God should not permit the exercise of its freedom to the soul, must affirm one of these two things; either that the soul, though by nature capable of indifferently choosing *good* or *evil*, should yet be constantly prevented from choosing evil; or else that it should have been made of such a nature as to have no *power* of choosing *evil*.

"The former assertion (continues he) is irrational and absurd; for what kind of liberty would that be in which there should be no freedom of choice? and what choice could there be, if the mind were constantly restrained to one side of every alternative? With respect to the second assertion, it is to be observed (says he), that no evil is in itself desirable, or can be chosen *as evil*. But if this power of determining itself either way in any given case must be taken from the soul, it must either be as something not good, or as some great evil. But whoever saith so, does not consider how many things there are which, though accounted good and desirable, are yet never put in competition with this freedom of will: for without it we should be on a level with the brutes; and there is no person who would rather be a brute than a man. If God then shows his goodness in giving to inferior beings such perfections as are far below this, is it incongruous to the divine nature and goodness to give man a self-determining power over his actions, and to permit him the free exercise of that power?

* Simplicius.
Com. in Epist.
pag.
186, 187.
ed. Salmesbury.

Providence power? Had God, to prevent man's sin, taken away the liberty of his will, he would likewise have destroyed the foundation of all virtue, and the very nature of man; for there could be no virtue were there not a possibility of vice; and man's nature, had it continued rational, would have been divine, because impeccable. Therefore (continues he), though we attribute to God, as its author, this self-determining power, which is so necessary in the order of the universe; we have no reason to attribute to him that evil which comes by the abuse of liberty: For God doth not cause that aversion from good which is in the soul when it sins; he only gave to the soul such a power as might turn itself to evil, out of which he produces much good, which, without such a power, could not have been produced by Omnipotence itself." So consonant to the doctrine of our scriptures is the reasoning of this opponent of the writings of Moses! *Fas est et ab hoste doceri.*

28
Objection
from the
apparent
confusion
of human
affairs,

The last objection to the belief of a divine providence arises from the apparent confusion of human affairs, that all things happen alike to all, that bad men are prosperous, and that a total want of justice appears to attend the divine administrations. Even the best men have at times been shaken by this consideration.— But there are many reasons for rendering this world a mixed scene: it would become unfit for a state of trial and of education to virtue were it otherwise.

29
Answered,

It has been shown already, that physical evil is the parent of moral good; and therefore it would be absurd to expect that the virtuous should be entirely exempted from that evil. For the occasional prosperity of the wicked, many reasons have been assigned even by those who, in their disquisitions, were not guided by that revelation which has brought to light life and immortality. "God (says Plutarch) spares the wicked, that he may set to mankind an example of forbearance, and teach them not to revenge their injuries too hastily on each other. He spares some wicked men from early punishment, in order to make them instruments of his justice in punishing others. And he spares all for a time, that they may have leisure for repentance; for men (says the same excellent moralist) look at nothing further, in the punishments which they inflict, than to satisfy their revenge and malice, and therefore they pursue those who have offended them with the utmost rage and eagerness; whereas God, aiming at the cure of those who are not utterly incurable, gives them *μετα(αλ- λισθαι) χρόνο*, "time to be converted."

30
By Plu-
tarch.

But this objection receives the best solution from the doctrine of the immortality of the human soul.

31
The im-
mortality
of the soul
the best an-
swer to
this objec-
tion.

— — — — — And see!

'Tis come, the glorious morn! the second birth
Of heav'n and earth! awakening nature hears
The new creating word, and starts to life,
In every height'ned form, from pain and death
For ever free. *The great eternal scheme,*
Involving all, and in a perfect whole
Uniting, as the prospect wider spreads,
To reason's eye cleared up apace.
Ye vainly wise! Ye blind presumptuous! now,
Confounded in the dust, adore that Pow'r
And Wisdom oft arraign'd: see now the cause,
Why unassuming worth in secret liv'd
And died neglected: why the good man's share

In life was gall and bitterness of soul:
Why the lone widow and her orphans pin'd
In starving solitude; while luxury,
In palaces, lay straining her low thought,
To form unreal wants: why heav'n-born truth,
And moderation fair, wore the red marks
Of superstition's scourge: why licens'd pain,
That cruel spoiler, that embosom'd foe,
Imbitter'd all our bliss. Ye good distress!
Ye noble few! who here unbending stand
Beneath life's pressure, yet bear up a while,
And what your bounded view, which only saw
A little part, deem'd evil, is no more:
The storms of wintry time will quickly pass,
And one unbounded spring encircle all.

Thomson's Winter.

PROVIDENCE-Plantation, a colony of New-England, which, with Rhode-island, formerly constituted a charter government. Its chief town is Newport.

PROVIDENCE, one of the least of the Bahama islands in the American ocean, but the best of those planted and fortified by the English. It is seated on the east side of the gulph of Florida. W. Long. 77. 35. N. Lat. 25. 0.

PROVINCE, in Roman antiquity, a country of considerable extent, which, upon being entirely reduced under the Roman dominion, was new-modelled according to the pleasure of the conquerors, and subjected to the command of annual governors, sent from Rome; being commonly obliged to pay such taxes and contributions as the senate thought fit to demand.

Of these countries, that part of France next the Alps was one, and still retains the name *Provence*.

Nicod derives the word *a procul vivendo*, "living afar off;" but it is better deduced from *pro* and *vinco* "I overcome."

PROVINCE, in geography, a division of a kingdom or state, comprising several cities, towns, &c. all under the same government, and usually distinguished by the extent either of the civil or ecclesiastical jurisdiction.

The church distinguishes its provinces by archbishoprics; in which sense, England is divided into two provinces, Canterbury and York.

The United Provinces are seven provinces of the Netherlands, who, revolting from the Spanish dominion, made a perpetual alliance, offensive and defensive, at Utrecht, anno 1579. See *UNITED PROVINCES*.

PROVINCIAL, something relating to a province. It also denotes, in Romish countries, a person who has the direction of the several convents of a province.

PROVISIONS, in a military sense, implies all manner of eatables, food or provender, used in an army, both for man and beast.

PROVOST of a city or town, is the chief municipal magistrate in several trading cities, particularly Edinburgh, Paris, &c. being much the same with mayor in other places. He presides in city-courts, and, together with the bailies, who are his deputies, determines in all differences that arise among citizens.

The provost of Edinburgh is called *lord*, and the same title is claimed by the provost of Glasgow. The former calls yearly conventions of the royal boroughs to Edinburgh by his missives, and is, *ex officio*, president to the convention when met.

Providence
||
Provost.

PRO-

The general instructions for pruning are as follow. The greatest care ought to be taken of fruit-trees in the spring, when they are in vigorous growth; which is the only proper season for procuring a quantity of good wood in the different parts of the tree, and for displacing all useless branches as soon as they are produced, in order that the vigour of the tree may be entirely distributed to such branches only as are designed to remain. For this reason trees ought not to be neglected in April and May, when their shoots are produced: however, those branches which are intended for bearing

Pruning. the succeeding year should not be shortened during the time of their growth, because this would cause them to produce two lateral shoots, from the eyes below the place where they were stopped, which would draw much of the strength from the buds of the first shoot: and if the two lateral shoots are not entirely cut away at the winter-pruning, they will prove injurious to the tree. This is to be chiefly understood of stone-fruit and grapes; but pears and apples, being much harder, suffer not so much, though it is a great disadvantage to those also to be thus managed. It must likewise be remarked, that peaches, nectarines, apricots, cherries, and plums, are always in the greatest vigour when they are least maimed by the knife; for where large branches are taken off, they are subject to gum and decay. It is therefore the most prudent method to rub off all useless buds when they are first produced, and to pinch others, where new shoots are wanted to supply the vacancies of the wall; by which management they may be so ordered as to want but little of the knife in winter-pruning. The management of pears and apples is much the same with these trees in summer; but in winter they must be very differently pruned: for as peaches and nectarines, for the most part, produce their fruit upon the former year's wood, and must therefore have their branches shortened according to their strength, in order to produce new shoots for the succeeding year; so, on the contrary, pears, apples, plums, and cherries, producing their fruit upon spurs, which come out of the wood of five, six, and seven years old, should not be shortened, because thereby those buds which were naturally disposed to form these spurs, would produce wood-branches; by which means the trees would be filled with wood, but would never produce much fruit. The branches of standard-trees should never be shortened unless where they are very luxuriant, and, by growing irregularly on one side of the trees, attract the greatest part of the sap, by which means the other parts are either unfurnished with branches, or are rendered very weak; in which case the branch should be shortened down as low as is necessary, in order to obtain more branches to fill up the hollow of the tree: but this is only to be understood of pears and apples, which will produce shoots from wood of three, four, or more years old; whereas most sorts of stone-fruit will gum and decay after such amputations: whenever this happens to stone-fruit, it should be remedied by stopping or pinching those shoots in the spring, before they have obtained too much vigour, which will cause them to push out side-branches; but this must be done with caution. You must also cut out all dead or decaying branches, which cause their heads to look ragged, and also attract noxious particles from the air: in doing of this, you should cut them close down to the place where they were produced, otherwise that part of the branch which is left will also decay, and prove equally hurtful to the rest of the tree; for it seldom happens, when a branch begins to decay, that it does not die quite down to the place where it was produced, and if permitted to remain long uncut, often infects some of the other parts of the tree. If the branches cut off are large, it will be very proper, after having smoothed the cut part exactly even with a knife, chisel, or hatchet, to put on a plaster of grafting clay, which will prevent the wet from soaking into the tree at the wounded part. All such branches as run across each other, and occasion a confusion in the head of the

tree, should be cut off; and as there are frequently young vigorous shoots on old trees, which rise from the old branches near the trunk, and grow upright into the head, these should be carefully cut out every year, lest, by being permitted to grow, they fill the tree too full of wood.

As to the pruning of forest-trees, if they be large, it is best not to prune them at all; yet, if there be an absolute necessity, avoid taking off large boughs as much as possible. And, 1. If the bough be small, cut it smooth, close, and sloping. 2. If the branch be large, and the tree old, cut it off at three or four feet from the stem. 3. If the tree grow crooked, cut it off at the crook, sloping upward, and nurse up one of the most promising shoots for a new stem. 4. If the tree grow top-heavy, its head must be lightened, and that by thinning the boughs that grow out of the main branches. But if you would have them spring, rub off the buds, and shroud up the side-shoots. 5. If the side-bough still break out, and the top be able to sustain itself, give the boughs that put forth in spring a pruning after Midsummer, cutting them close.

PRUNUS, in botany: A genus of the monogynia order, belonging to the icofandria class of plants; and in the natural method ranking under the 36th order, *Pomacea*. The calyx is quinquesid, inferior; there are five petals; the fruit is a plum, having a kernel with prominent sutures. There are 15 species, of which six are cultivated in Britain: they are originally natives of America and Siberia.

1. The domestica, or common plum-tree, grows 20 or 30 feet high, garnished with oval, spear-shaped leaves, and with the pedunculi for the most part single, terminated by flowers, succeeded by plums of many different colours, sizes, and shapes in the varieties. 2. The insititia, wild-plum, or bullace-tree, grows 12 or 15 feet high; the branches somewhat spinous; the leaves oval, hairy underneath; and the pedunculi by pairs, terminated by white flowers succeeded by small, round, plum-like, fruit of different colours in the varieties. 3. The spinosa, black-thorn, or sloe-tree, grows 10 or 12 feet high, very branchy and bushy quite from bottom, armed with strong, sharp spines, small, spear-shaped, smooth leaves, pedunculi growing singly, terminated by flowers, succeeded by small, round, black cherries in autumn. It grows wild everywhere in hedges and woods; and is very proper for planting field hedges, being of very quick and close growth. 4. The cerasus, or common cherry-tree, grows 20 feet or more in height, garnished with oval clusters of lanceolate, smooth leaves, umbellate flowers, succeeded by clusters of red roundish fruit of different sizes and properties in the varieties. Hanbury says, "were this tree scarce, and with much difficulty propagated, every man, though possessed of a single tree only, would look upon it as a treasure; for besides the charming appearance these trees have, when besnowed, as it were, all over with bloom in the spring, can any tree in the vegetable tribe be conceived more beautiful, striking, and grand, than a well-grown and healthy cherry-tree, at that period when the fruit is ripe."

The many kinds of cherry-trees afford an almost endless variety; all differing in some respect in their manner of shooting, leaves, flowers, or fruit: two in particular demand admission into the pleasure-garden; the double-blossomed and the red-flowering. The pleasing show the common cherry-tree makes when in blow is

Pruning.

known to all; but that of the double-blossomed is much more enchanting. It blossoms like the other in May; the flowers are produced in large and noble clusters; for each separate flower is as double as a rose, is very large, and placed on long and slender footstalks, so as to occasion the branches to have an air of ease and freedom. They are of a pure white; and the trees will be so profusely covered with them, as to charm the imagination. Standards of these trees, when viewed at a distance, have been compared to balls of snow; and the nearer we approach, the greater pleasure we receive. These trees may be kept as dwarfs, or trained up to standards; so that there is no garden or plantation to which they will not be suitable. By the multiplicity of the petals the organs of generation are destroyed; so that those flowers which are really full are never succeeded by any fruit.

The red-flowering cherry-tree differs in no respect from the common cherry-tree, only that the flowers are of a pale-red colour, and by many are esteemed on that account. Besides the ornament and utility afforded us by the flowers and fruit of the cherry, its timber is a further inducement for propagating it; more especially that of the small black wilding sort; which may perhaps with propriety be considered as the genuine species, and a native of this island. Be this as it may, it will grow, in a soil and situation it affects, to be a large timber tree; which, if taken in its prime before it become tainted at the heart, will turn out perhaps not less than a ton of valuable materials, peculiarly adapted to the purposes of furniture. The grain is fine, and the colour nearly approaching to that of mahogany, to which valuable wood it comes nearer than any other which this country produces. 5. The avium, or great wild-cherry tree, grows 40 or 50 feet high, having oval, spear-shaped leaves, downy underneath, with umbellate sessile clusters of white flowers, succeeded by small round fruit of different properties in the varieties. 6. The padus, or common bird-cherry tree, grows 15 or 20 feet high, of a shrub-like growth, with a spreading head, large, oblong, rough, serrated leaves, having two glands at the back of the base like the other, and with shorter, more compact clusters of flowers, succeeded by large red fruit. This grows wild in hedges in the north parts of England. 7. The Virginiana, or Virginian bird-cherry, grows 30 feet high, dividing into a very branchy head, having a dark purple bark, oval, slightly serrated, shining green leaves, having two glands at the forepart of the base, and long clusters of white flowers, succeeded by small, round, berry-like, black fruit. 8. The Canadensis, or Canada dwarf bird cherry, grows but four or five feet high, branching horizontally near the ground with smooth branches; broad, spear-shaped, rough downy leaves without glands; and long clusters of white flowers, succeeded by small, round, berry-like, black fruit, ripe in autumn. 9. The mahaleb, or perfumed cherry, grows 10 or 15 feet high, with smooth whitish branches, small, oval, shining green leaves, and corymbose clusters of white flowers, succeeded by small fruit. 10. The armeniaca, or apricot tree, grows 20 feet high,

with a large spreading head, having reddish shoots, large nearly heart-shaped leaves, and close-fitting pale-red flowers rising all along the sides of the young branches; succeeded by large, roundish fruit of a yellow and reddish colour in different varieties. The fruit and the kernels of the *Prunus Siberica*, when eaten, excite a continued head-ach: the kernels, infused in brandy, communicate an agreeable flavour.

Culture. All the different varieties of plums have at first been raised from the stones, and are afterwards preserved by budding and grafting on any plum-stock. The same method is applicable to cherries; only these are grafted to most advantage upon stocks of the wild black and red cherry raised from the stones of the fruit. The apricot-trees are propagated by budding on any kind of plum-stocks.

PRUSA (anc. geog.), a town situated at mount Olympus in Mylia, built by Prusias, who waged war with Croesus, (Strabo); with Cyrus, (Stephanus); both cotemporary princes. Now called *Bursa* or *Prusa*, capital of Bithynia, in Asia Minor. E. Long. 29. 5. N. Lat. 39. 22.

PRUSIAS, the name of several kings of Bithynia.

PRUSIAS, a town of Bithynia, anciently called *Cios*, from a cognominal river, and giving name to the Sinus Cianus of the Propontis; rebuilt by Prusias the son of Zela, after having been destroyed by Philip the son of Demetrius: it stood on the Sinus Cianus, at the foot of mount Arganthonius. This is the Prusias who harboured Annibal after the defeat of Antiochus.—Of this place was Asclepiades, surnamed *Prusæus*, the famous physician.

PRUSSIA, a modern; but deservedly celebrated kingdom of Europe, whose monarch, along with Prussia Proper, possesses also the electorate of Brandenburg, and some other territories of considerable extent. The district properly called *Prussia* is of great extent, and divided into the Ducal and Regal Prussia, the latter belonging to the republic of Poland till the late partition of the Polish territories. Both together are of great extent; being bounded on the north by the Baltic, on the south by Poland and the duchy of Mazovia, on the west by Pomerania, and on the east by Lithuania and Samogitia. The name is by some thought to be derived from the *Borussi*, a tribe of the Sarmatians, who, migrating from the foot of the Rhipæan mountains, were tempted by the beauty and fertility of the country to settle there. Others think that the name of this country is properly *Porussia*; *Po* in the language of the natives signifying *near*, and *Porussia* signifying *near Russia*. To the latter etymology we find the king of Prussia himself assenting in the treatise intitled *Memoirs of the House of Brandenburg*. However, it must be owned, that these or any other etymologies of the word are very uncertain, and we find nothing like it mentioned by historians before the tenth century.

The ancient state of Prussia is almost entirely unknown. However, the people are said to have been very savage and barbarous; living upon raw flesh, and drinking the blood of horses at their feasts, according to Stella, even to intoxication (A). Nay, so extremely

Prusa
||
Prussia.

Plate
CCCCX.

Etymology
of the
name.

2
Extreme
barbarity
of the an-
cient inha-
bitants.

(A) This author does not mention any particular method by which they communicated an inebriating quality to the blood of animals. Possibly, however, the vital fluid may have a property of this kind, though unknown in our days where such barbarous customs are disused. Drunkenness from drinking blood is frequently mentioned in Scripture, but whether literally or metaphorically must be decided by the learned.

Prussia.

ly savage were this people, that they were even unacquainted with the method of constructing huts, and took up their dwelling in caves and cavities of rocks and trees, where they protected themselves and children from the inclemencies of the weather. Among such a people it is vain to expect that any transactions would be recorded, or indeed that any thing worthy of being recorded would be transacted. We shall therefore begin our history of Prussia with the time when the Teutonic knights first got footing in the country. (See *TEUTONIC KNIGHTS*).

3
Teutonic
knights
first get
footing in
the coun-
try.

On the expulsion of the Christians from the Holy Land by Saladin, a settlement was given to the Teutonic knights in Prussia by Conrade duke of Mazovia, the competitor of Boleslaus V. for the crown of Poland. Their first residence in this country was Culm; to which territory they were confined by the conditions of the donation, excepting what they could conquer from their pagan neighbours, all which the emperor granted to them in perpetuity.

Encouraged by this grant, the knights conquered the greatest part of the country which now goes by the name of *Prussia*; and, not content with this, became very troublesome to Poland, insomuch that the monarchs of that kingdom were sometimes obliged to carry on dangerous and bloody wars with them; for an account of which we refer to the article *POLAND*, n° 61. 67, &c.

The Teutonic order continued in Prussia till the year 1531. Their last grand-master was Albert marquis of Brandenburg, and nephew to Sigismund I. king of Poland. He was preferred to this dignity in hopes that his affinity to Sigismund might procure a restitution of some of the places which had been taken from the order during the former unsuccessful wars with Poland; but in this the fraternity were disappointed. Albert, however, was so far from endeavouring to obtain any favour from his uncle by fair means, that he refused to do homage to him, and immediately began to make preparations for throwing off his dependence altogether, and recovering the whole of Prussia and Pomerania by force of arms. In this he was so far from succeeding, that, being foiled in every attempt, he was forced to resign the dignity of grand-master; in recompense for which, his uncle bestowed on him that part of Prussia now called *Ducal*, in quality of secular duke. It was now the interest of the house of Brandenburg to assist in the expulsion of the fraternity; and accordingly, being at last driven out of Prussia and Pomerania, they transferred their chapter to Mariendal in Franconia; but in that and other provinces of the empire where they settled, little more than the name of the order once so famous now remains.

4
Expelled.

5
History of
Branden-
burg.

The other most considerable part of his Prussian majesty's dominions is the Electorate of Brandenburg. Like other parts of Germany, it was anciently possessed by barbarians, of whom no history can be given. These were subdued by Charlemagne, as is related under the article *FRANCE**; but being on every occasion ready to revolt, in 927 Henry the Fowler established margraves, or governors of the frontiers, to keep the barbarians in awe. The first margrave of Brandenburg was Sigefroy, brother-in-law to the above-mentioned emperor; under whose administration the bishoprics of Brandenburg and Havelberg were established by Otho I. From this Sigefroy, to the succession of the house of

* N° 27,
&c.

Prussia.

Hohenzollern, from whom the present elector is descended, there are reckoned eight different families, who have been margraves of Brandenburg; namely, the family of the Saxons, of Walbeck, Staden, Plenek, Anhalt, Bavaria, Luxemburg, and Misnia. The margraves of the four first races had continual wars with the Vandals and other barbarous people; nor could their ravages be stopped till the reign of Albert surnamed *the Bear*, the first prince of the house of Anhalt. He was made margrave by the emperor Conrad III. and afterwards raised to the dignity of elector by Frederic Barbarossa, about the year 1100. Some years afterwards the king of the Vandals dying without issue, left the Middle Marche by his last will to the elector, who was besides possessed of the old March, Upper Saxony, the country of Anhalt, and part of Luface. In 1332 this line became extinct, and the electorate devolved to the empire. It was then given by the emperor Louis of Bavaria to his son Louis, who was the first of the sixth race. Louis the Roman succeeded his brother; and as he also died without children, he was succeeded by Otho, his third brother, who sold the electorate to the emperor Charles IV. of the house of Luxemburg, for 200,000 florins of gold. Charles IV. gave the Marche to his son Wineflaus, to whom Sigismund succeeded. This elector, being embarrassed in his circumstances, sold the New Marche to the knights of the Teutonic order. Joffe succeeded Sigismund; but aspiring to the empire, sold the electorate to William duke of Misnia; who, after he had possessed it for one year, sold it again to the emperor Sigismund. In 1417, Frederic VI. burgrave of Nuremberg, received the investiture of the country of Brandenburg at the diet of Constance from the hands of the emperor Sigismund; who, two years before, had conferred upon him the dignity of elector, and arch-chamberlain of the Holy Roman empire.

This prince, the first of the family of Hohenzollern, found himself possessed of the Old and Middle Marche, but the dukes of Pomerania had usurped the Marche Ukraine. Against them, therefore, the elector immediately declared war, and soon recovered the province. As the New Marche still continued in the hands of the Teutonic knights, to whom it had been sold as we have already mentioned, the elector, to make up for this, took possession of Saxony, which at that time happened to be vacant by the death of Albert the last elector of the Anhalt line. But the emperor, not approving of this step, gave the investiture of Saxony to the duke of Misnia; upon which Frederic voluntarily desisted from his acquisitions. This elector made a division of his possessions by will. His eldest son was deprived of his right on account of his having too closely applied himself to search for the philosopher's stone; so he left him only Veigland. The electorate was given to his second son Frederic; Albert, surnamed *Achilles*, had the duchies of Franconia; and Frederic, surnamed *the Fat*, had the Old Marche; but by his death it returned to the electorate of Brandenburg.

Frederic I. was succeeded by his son, called also *Frederic*, and surnamed *Iron-tooth* on account of his strength. He might with as great reason have been surnamed *the Magnanimous*, since he refused two crowns, viz. that of Bohemia, which was offered him

Prussia.

by the pope, and the kingdom of Poland to which he was invited by the people; but Frederic declared he would not accept of it unless Casimir brother to Ladislaus the late king refused it. These instances of magnanimity had such an effect on the neighbouring people, that the states of Lower Lusatia made a voluntary surrender of their country to him. But as Lusatia was a fief of Bohemia, the king of that country immediately made war on the elector, in order to recover it. However, he was so far from being successful, that, by a treaty of peace concluded in 1462, he was obliged to yield the perpetual sovereignty of Corbus, Peits, Sommerfeld, and some other places, to the elector. Frederic then, having redeemed the New Marche from the Teutonic order for the sum of 100,000 florins, and still further enlarged his dominions, resigned the sovereignty in 1469 to his brother Albert, surnamed *Achilles*.

6
Exploits of
Albert sur-
named *A-*
chilles.

Albert was 57 years old when his brother resigned the electorate to him. Most of his exploits, for which he had the surname of *Achilles*, had been performed while he was burgrave of Nuremberg. He declared war against Lewis duke of Bavaria, defeated, and took him prisoner. He gained eight battles against the Nurembergers, who had rebelled and contested his rights to the burgraviate. In one of these he fought singly against 16 men, till his people came up to his assistance. He made himself master of the town of Greiffenburg in the same manner that Alexander the Great took the capital of the Oxydracæ, by leaping from the top of the walls into the town, where he defended himself singly against the inhabitants till his men forced the gates and rescued him. The confidence which the emperor Frederic III. placed in him, gained him the direction of almost the whole empire. He commanded the Imperial armies against Lewis the Rich duke of Bavaria; and against Charles the Bold duke of Burgundy, who had laid siege to Nuis, but concluded a peace at the interposition of Albert. He gained the prize at 17 tournaments, and was never dismounted.

7
Prussia and
Branden-
burg unit-
ed.

All these exploits, however, had been performed before Albert obtained the electorate. From that time we meet with no very important transactions till the year 1594, when John Sigismund of Brandenburg, having married Anne the only daughter of Albert duke of Prussia, this united that duchy to the electorate, to which it has continued to be united ever since; and obtained pretensions to the countries of Juliers, Berg, Cleves, Marck, Ravensburg, and Ravensstein, to the succession of which Anne was heiress.

8
Unfortu-
nate reign
of the elec-
tor George
William.

Sigismund died in 1619, and was succeeded by his son George William; during whose government the electorate suffered the most miserable calamities. At this time it was that the war commenced between the Protestants and Catholics, which lasted 30 years. The former, although leagued together, were on the point of being utterly destroyed by the Imperialists under the command of Count Tilly and Wallenstein, when Gustavus Adolphus of Sweden turned the scale in their favour, and threatened the Catholic party with utter destruction*. But by his death at the battle of Lutzen, the fortune of war was once more changed. At last, however, peace was concluded with the emperor; and, in 1640, the elector died, leaving his do-

* See *Sax-*
den.

minions to his son Frederic William, surnamed the *Great*. Prussia.

This young prince, though only 20 years of age at the time of his accession, applied himself with the utmost diligence to repair the losses and devastations occasioned by the dreadful wars which had preceded. He received the investiture of Prussia personally from the king of Poland, on condition of paying 100,000 florins annually, and not making truce or peace with the enemies of that crown. His envoy likewise received the investiture of the electorate from the emperor Ferdinand III. The elector then thought of recovering his provinces from those who had usurped them. He concluded a truce for 20 years with the Swedes, who evacuated the greatest part of his estates. He likewise paid 140,000 crowns to the Swedish garrisons, which still possessed some of his towns; and he concluded a treaty with the Hessians, who delivered up a part of the duchy of Cleves; and obtained of the Hollanders the evacuation of some other cities.

In the mean time, the powers of Europe began to be weary of a war which had continued for such a length of time with such unrelenting fury. The cities of Osnaburg and Munster being chosen as the most proper places for negotiation, the conferences were opened in the year 1645; but, by reason of the multiplicity of business, they were not concluded till two years after. France, which had espoused the interests of Sweden, demanded that Pomerania should be ceded to that kingdom as an indemnification for the expences which the war had cost Gustavus Adolphus and his successors. Although the empire and the elector refused to give up Pomerania, it was at last agreed to give up to the Swedes Hither Pomerania, with the isles of Rugen and Wollin, also some cities; in return for which cession, the bishoprics of Halberstadt, Minden, and Camin, were secularized in favour of the elector, of which he was put in possession, together with the lordships of Hohenstein and Richenstein, with the reversion of the archbishopric of Magdeburg. This was the treaty of Westphalia concluded in 1648, and which serves as a basis to all the possessions and rights of the German princes. The elector then concluded a new treaty with the Swedes, for the regulation of limits, and for the acquittal of some debts, of which Sweden would only pay a fourth; and next year the electorate, Pomerania, and the duchies of Cleves, were evacuated by the Swedes.

10
Treaty of
Westphalia
concluded.

Notwithstanding all these treaties, however, the Swedes soon after invaded Pomerania, but were entirely defeated by the elector near the town of Fehrbellin. Three thousand were left dead on the spot, among whom were a great number of officers; and a great many were taken prisoners. The elector then pursued his victory, gained many advantages over the Swedes, and deprived them of the cities of Stralsund and Gripiwald. On this the Swedes, hoping to oblige the elector to evacuate Pomerania, which he had almost totally subdued, invaded Prussia, from Livonia, with 16,000 men; and advancing into the country, they burned the suburbs of Memel, and took the cities of Tilske and Insterburg. The elector, to oppose the invaders, left Berlin on the 10th of January 1679, at the head of 9000 men. The Swedes retired at his approach, and were greatly harassed by the

11
The elec-
tor succeeds
against the
Swedes.

Prussia.

the troops on their march. So successful indeed was the elector on this occasion, that the Swedes lost almost one half of their army killed or taken prisoners. At last, having crossed the bay of Frisch-haff and Courland on the ice, he arrived on the 19th of January, with his infantry, within three miles of Tilse, where the Swedes had their head-quarters. The same day, his general, Trefenfeldt, defeated two regiments of the enemy near Splitter; and the Swedes who were in Tilse abandoned that place, and retired towards Courland. They were pursued by General Gortz, and entirely defeated with such slaughter, that scarce 3000 of them returned to Livonia. Yet, notwithstanding all these victories, the elector, being pressed on the other side by the victorious generals of France, M. Turenne and the prince of Conde, was obliged to make peace with the Swedes. The conditions were, that the treaty of Westphalia should serve for a basis to the peace; that the elector should have the property of the customs in all the ports of Further Pomerania, with the cities of Camin, Gartz, Grieffenburg, and Wildenbruck: on his part, he consented to give up to the Swedes all that he had conquered from them, and to give no assistance to the king of Denmark, upon condition that France delivered up to him his provinces in Westphalia, and paid him 300,000 ducats, as an indemnification for the damages done by the French to his states. This treaty was styled *the peace of St Germain*.

12
Is obliged
to conclude
a treaty of
peace with
them.

13
A strange
embassy
from the
cham of
Tartary.

With the treaty of St Germain terminated the military exploits of Frederic William, who passed the last years of his administration in peace. His great qualities had rendered him respected by all Europe, and had even been heard of in Tartary. He received an embassy from Murad Geray, cham of the Tartars, courting his friendship. The barbarian ambassador appeared in such tattered clothes as scarce covered his nakedness, so that they were obliged to furnish him with other clothes before he could appear at court. His interpreter had a wooden nose and no ears. In 1684, Frederic received into his dominions great numbers of Protestants who fled out of France from the persecutions of Louis XIV. after he had revoked the edict of Nantz. Twenty thousand of them are said to have settled at this time in the electorate, where they introduced new arts and manufactures, that were of the utmost benefit to the country. By this, however, he disobliged Louis XIV. for which reason he concluded an alliance with the emperor; and having furnished him with 8000 troops against the Turks in Hungary, the emperor yielded to him the circle of Schwibus in Silesia, as an equivalent for all his rights in that province.

14
Frederic II.
obtains the
title of
king of
Prussia.

In 1688, the elector Frederic William died, and was succeeded by his son Frederic III. This prince was remarkably fond of show and ceremony, which, during the course of his government, involved him in much expence. The regal dignity seemed to be the greatest object of his ambition. To obtain this, he joined with the emperor in the alliance against France, in which he was engaged by William III. king of Britain. He also yielded up the circle of Schwibus, which had been given to his predecessor; and, in 1700, obtained from the emperor that dignity which he had so earnestly desired. The terms on which it was ob-

tained were, 1. That Frederic should never separate from the empire those provinces of his dominions which depended on it. 2. That he should not, in the emperor's presence, demand any other marks of honour than those which he had hitherto enjoyed. 3. That his Imperial majesty, when he wrote to him, should only give him the title of *Royal Dilection*. 4. That nevertheless the ministers which he had at Vienna should be treated like those of other crowned heads. 5. That the elector should maintain 6000 men in Italy at his own expence, in case the emperor should be obliged to make war on account of the succession of the house of Bourbon to the crown of Spain. 6. That those troops should continue there as long as the war lasted.

Thus was the kingdom of Prussia established through the friendship of the emperor, with whom Frederic I. so called as being the first king of Prussia, continued all his life in strict alliance. Indeed he was a pacific prince; and though contemptible in his person, and incapable of achieving great things, had this merit, that he always preserved his dominions in peace, and thus consulted the true interest of his subjects much more than those monarchs who have dazzled the eyes of the world by their military exploits. He was indeed vain, and fond of show, as we have already observed; but had a good heart, and is said never to have violated his conjugal vow; though it does not appear that he was greatly beloved by his royal consorts (of whom he had three) on that or any other account.

Frederic I. died in the beginning of 1713, and was succeeded by Frederic William. He was in almost every thing the reverse of his father. His dispositions were altogether martial; so that he applied himself entirely to the augmentation of his army, and perfecting them in their exercise, by which means they became the most expert soldiers in Europe. His foible was an ambition of having his army composed of men above the ordinary size; but as these could not be procured, he composed a regiment of the tallest men he could find; and as his officers made no scruple of picking up such men wherever they could find them for his majesty's use, the neighbouring states were frequently offended, and a war was often likely to ensue even from this ridiculous cause. However, his Prussian majesty was never engaged in any martial enterprise of consequence: but having put his army on the most respectable footing of any in the world, and filled his coffers, for he was of a very saving disposition, he put it in the power of his son to perform those exploits which have been matter of astonishment to all Europe.

It was in this king's reign that Prussia first perceived her natural enemy and rival to be the house of Austria, and not France as had been formerly supposed. Hence frequent bickerings took place between these two powers, for which the persecution of the Protestants by some of the Catholic states of the empire afforded a pretence; and though a war never actually took place, yet it was easy to see that both were mortal enemies to each other. But when Frederic William died in 1740, this enmity broke out in full force. The empress queen was then left in a very disagreeable situation, as has been observed under the article Britain, n^o 410, &c. Of this Frederic II. took the advantage to do himself justice, as he said, with regard

Prussia.

15
Frederic II.
of Prussia
a martial
prince.

16
Enmity be-
tween
Prussia and
Austria.

17
Frederic II.
seizes Si-
lesia.

¹⁷ Prussia. to Silesia, of which his ancestors had been unjustly deprived. This province he seized at that time: but it cost him dear; for the empress, having at last overcome all difficulties, formed against him the most terrible combination that ever was known in Europe.

¹⁸ Combina-
tion against
him. The treaty was hardly concluded with the king of Prussia, by which she reluctantly yielded up the province of Silesia, and with it a clear revenue of L. 800,000 a-year, before she entered into another with the court of Petersburg, which was concluded May 22. 1746. This treaty, as far as it was made public, was only of a defensive nature; but six secret and separate articles were added to it. By one of these it was provided, that in case his Prussian majesty should attack the empress queen, or the empress of Russia, or even the republic of Poland, it should be considered as a breach of the treaty of Dresden, by which Silesia was given up. It was also stipulated, that, notwithstanding that treaty (which indeed had been dictated by the king of Prussia himself), the right of the empress-queen to Silesia still continued, and for the recovery of that province the contracting powers should mutually furnish an army of 60,000 men. To this treaty, called the treaty of *Petersburg*, the king of Poland was invited to accede; but he, being in a manner in the power of the king of Prussia, did not think proper to sign it: however, he verbally acceded to it in such a manner, that the other parties were fully convinced of his design to co-operate with all their measures; and in consideration of this intention, it was agreed that he should have a share in the partition of the king of Prussia's dominions, in case of a successful event of their enterprises.

In consequence of these machinations, every art was used to render the king of Prussia personally odious to the empress of Russia; the queen of Hungary made vast preparations in Bohemia and Moravia; and the king of Poland, under pretence of a military amusement, drew together 16,000 men, with whom he occupied a strong post at Pirna. The queen of Hungary, still further to strengthen herself, concluded a treaty with the court of France at Versailles, dated May 1. 1756. But in the mean time, the king of Prussia having understood by his emissaries what was going forward, resolved to be beforehand with his enemies, and at least to keep the war out of his own country: and therefore entered Saxony with a considerable army. At first he affected only to demand a free passage for his troops, and an observance of the neutrality professed by the king of Poland; but, having good reasons to doubt this neutrality, he demanded, as a preliminary, that these Saxon troops should immediately quit the strong post they occupied, and disperse themselves. This demand was refused; on which his Prussian majesty blockaded the Saxon camp at Pirna, resolving to reduce it by famine, since its strong situation rendered an attack very dangerous. At that time there were in Bohemia two Saxon armies, one under the command of M. Brown, and the other under M. Piccolomini. To keep these in awe, the king had sent M. Schwerin with an army into Bohemia from the country of Glatz, and M. Keith had penetrated into the same kingdom on the side of Misnia. But still the king of Prussia did not entirely confide in these dispositions;

and therefore fearing lest M. Brown might afford some assistance to the Saxons, he joined his forces under Keith, and on December 1. attacked and defeated the Austrian general, so that the latter found it impossible to relieve the Saxons, who, after a vain attempt to retire from their post, were all taken prisoners. The king of Poland quitted his dominions in Germany, and the Prussians took up their winter-quarters in Saxony. Here they seized on the revenues, levied exorbitant contributions, and obliged the country to furnish them with recruits. The king of Prussia at this time made himself master of the archives of Dresden, by which means he procured the originals of those pieces above-mentioned, which, when produced to the world, gave a full proof of the combination that had been formed against him, and consequently justified the measures he had taken for his own defence.

No sooner had the king entered Saxony, in the manner already related, than a process was commenced against him in the emperor's Aulic council, and before the diet of the empire, where he was soon condemned for contumacy, and put to the ban of the empire. The various circles of the empire were ordered to furnish their contingents of men and money to put this sentence in execution; but these came in so slowly, that, had it not been for the assistance of the French under the prince de Soubise, the army would probably have never been in a condition to act. The Austrians, in the mean time, made great preparations, and raised 100,000 men in Bohemia, whom they committed to the care of prince Charles of Lorraine, assisted by M. Brown. The Czarina sent a body of 60,000 men under M. Apraxin, to invade the Ducal Prussia; whilst a strong fleet was equipped in the Baltic, in order to co-operate with that army. The king of Sweden also acceded to the confederacy, in hopes of recovering the possessions in Pomerania which his ancestors had enjoyed; and the duke of Mecklenburg took the same party, promising to join the Swedish army with 6000 men as soon as it should be necessary. On the king of Prussia's side appeared nobody excepting an army of between 30,000 and 40,000 Hanoverians commanded by the duke of Cumberland; and these were outnumbered and forced to yield to a superior army of French commanded by M. D'Etrees.

¹⁹ He invades Saxony. In the mean time, his Prussian majesty, finding that he must depend for assistance solely on his own abilities, resolved to make the best use of his time. Accordingly, in the spring 1757, his armies poured into Bohemia from two different quarters, while the king himself prepared to enter it from a third. M. Schwerin entered from Silesia; the prince of Bevern from Lusatia, where he defeated an army of 28,000 Austrians that opposed his passage. As the intentions of the king himself were not known, the Austrians detached a body of 20,000 men from their main army to observe his motions. This was no sooner done than the king cut off all communication between the detachment and the main body; and having joined his two generals with incredible celerity, he engaged the Austrians near Prague, totally defeated them, took their camp, military chest, and cannon; but lost the brave general Schwerin, who was killed at the age of 82, with a colonel's standard in his hand. On the Austrian side

Prussia side, M. Brown was wounded, and died in a short time, though it is supposed more from the chagrin he suffered, than from the dangerous nature of the wound itself.

24
Besieges
and bom-
bards
Prague.

About 40,000 of the Austrian army took refuge in Prague, while the rest fled different ways. The city was instantly invested by the king, and all succours were cut off. The great number of troops which it contained rendered an attack unadvisable, but seemed to render the reduction of it by famine inevitable; however, the king, to accomplish his purpose the more speedily, prepared to bombard the town. On the 29th of May, after a most dreadful storm of thunder and lightning, four batteries began to play on the city. From these were thrown, every 24 hours, 288 bombs, besides a vast number of red-hot balls, so that it was soon on fire in every quarter. The garrison made a vigorous defence, and one well-conducted sally; but had the misfortune to be repulsed with great loss. The magistrates, burghers, and clergy, seeing their city on the point of being reduced to an heap of rubbish, supplicated the commander in the most earnest manner to capitulate; but he was deaf to their intreaties, and drove 12,000 of the most useless mouths out of town, who were quickly driven in again by the Prussians.

25
Count
Daun takes
the com-
mand of
the Au-
strian ar-
my.

Thus the affairs of the empress queen seemed verging to destruction, when Leopold count Daun took upon him the command of the remains of M. Brown's army. This general had arrived within a few miles of Prague the day after the great battle. He immediately collected the scattered fugitives with the greatest diligence, and retired with them to a strong post in the neighbourhood, from whence he gave the troops in Prague hopes of a speedy relief. It was now the king of Prussia's business, either to have attempted to make himself master of the city by one desperate effort, or entirely to have abandoned the enterprise, and driven count Daun from his post before his troops had recovered from the terror of their late defeat; but, by attempting to do both, he rendered himself incapable of doing either. Though the army of count Daun already amounted to 60,000 men, and though they were strongly entrenched, and defended by a vast train of artillery, his majesty thought proper to send no more than 32,000 men. This body made the arduous attempt on the 18th of June; but though they did all that human courage and conduct could do, and though the king himself at last charged at the head of his cavalry, the Prussians were driven out of the field with great loss. This engagement was named *the battle of Colin*.

26
Defeats the
Prussians at
Colin.

27
Siege of
Prague
raised.

The first consequence of the battle of Colin was, that the king of Prussia was obliged to raise the siege of Prague; soon after which, he was obliged to quit Bohemia, and take refuge in Saxony. The Austrians harassed him as much as possible; but, notwithstanding their great superiority, their armies were not in a condition to make any decisive attempt upon him, as the frontiers of Saxony abounded with situations easily defended. In the mean time, the Russians, who had hitherto been very dilatory in their motions, began to exert themselves, and enter Ducal Prussia, under M. Apraxin and Fermor, where they committed innumerable cruelties and excesses. A large body of Austrians entered Silesia, and penetrated as far as

Breslau. Then they made a turn backwards, and besieged Schweidnitz. Another body entered Lusatia, and made themselves masters of Zittau. An army of 22,000 Swedes entered Prussian Pomerania, took the towns of Anclam and Demmein, and laid the whole country under contribution. The French, too, being freed from all restraint by the capitulation of the duke of Cumberland at Closter Seven, made their way into Halbertstadt and the Old Marche of Brandenburg, first exacting contributions, and then plundering the towns. The army of the empire, being reinforced by that of the prince de Soubise, after many delays, was on full march to enter Saxony, which left the Austrians at liberty to exert the greatest part of their force in the reduction of Silesia. General Haddiek penetrated through Lusatia, passed by the Prussian armies, and suddenly appeared before the gates of Berlin, which city he laid under contribution. He retired on the approach of a body of Prussians; yet he still found means to keep such a post as interrupted the king's communication with Silesia. The destruction of the king of Prussia therefore now seemed inevitable. Every exertion which he had made, though brave and well-conducted, had been unsuccessful. His general Lehwald, who opposed the Russians, had orders to attack them at all events. He obeyed his orders; and with 30,000 men attacked 60,000 of the enemy strongly entrenched at a place called *Norkitten*. The Prussians behaved with the greatest valour; but after having killed five times more of the enemy than they themselves lost, they were obliged to retire, though more formidable after their defeat than the Russians after their victory. The king, in the mean time, exerted himself on every side, and his enemies fled everywhere before him; but whilst he pursued one body, another gained upon him in some other part, and the winter came on fast, while his strength decayed, and that of his adversaries seemed to increase on every quarter.

The Prussian monarch, however, though distressed, did not abandon himself to despair, or lose that wonderful presence of mind which has so eminently distinguished him in all his military enterprises. He industriously delayed a decisive action till the approach of winter; but at last, after various movements, on November 5. 1757, he met at Rosbach with the united army of his enemies commanded by the prince of Saxe-Hilburghausen and the prince de Soubise. The allied army amounted to 50,000 men complete; but most of the troops of the Circles were new-raised, and many of them not well affected to the cause. The Prussians did not exceed 25,000 men; but they were superior to any troops in the world, and were inspired, by the presence of their king, with the most enthusiastic valour. The Austrians were defeated with the loss of 3000 killed, eight generals, 250 officers of different ranks, and 6000 private soldiers, taken prisoners, while night alone prevented the total destruction of the army.

By this battle the king was set free on one side; but this only gave him an opportunity of renewing his labours on another. The Austrians had a great force, and now began to make a proportionable progress in Silesia. After a siege of 16 days, they had reduced the strong fortress of Schweidnitz, and obliged the

Prussia.

See Brit.
TAIN, ii.
441.

28
Berlin laid
under con-
tribution.

29
Lehwald a
Prussian ge-
neral de-
feated by
the Rus-
sians.

30
The king
gains a
great vic-
tory at
Rosbach.

Prussia.
31
Schweid-
nitz taken
by the Au-
strian.

32
Battle with
the prince
of Bevern.

33
Breslau ra-
ken by the
Austrians.

34
Garrison of
Schweid-
nitz re-
cover their
liberty.

35
Count
Daun de-
feated by
the king
of Prussia
at Leuthen.

the Prussian garrison of 4000 men to surrender prisoners of war. Hearing then of the victory at Rosbach, and that the king of Prussia was in full march to relieve Silesia, they resolved to attack the Prince of Bevern in his strong camp under the walls of Breslau. They attacked the Prince's army on November 22d; but their attack was sustained with the greatest resolution. The slaughter of the Austrians was prodigious. A great part of the enemy had retired from the field of battle, and the rest were preparing to retire, when all at once the Prussian generals took the same resolution. Their army had suffered much in the engagement, and they became apprehensive of a total defeat in case their intrenchments should be forced in any part; for which reason they quitted their strong post, and retired behind the Oder. Two days after, the prince of Bevern, going to reconnoitre without escort, attended only by a groom, was taken prisoner by an advanced party of Croats, a small body of whom had crossed the Oder.

On this the town of Breslau immediately surrendered; where, as well as at Schweidnitz, the Austrians found great quantities of provisions, ammunition, and money. All Silesia was on the point of falling into their hands, and the Prussian affairs were going into the utmost distraction, when the king himself by a most rapid march passed through Thuringia, Misnia, and Lusatia, in spite of the utmost efforts of the generals Haddick and Marshal, who were placed there to oppose him; and, entering Silesia on the 2d of December, joined the prince of Bevern's corps, who repassed the Oder to meet him. The garrison of Schweidnitz, who, as we have already observed, had been made prisoners of war, also joined the king's army unexpectedly; and their presence contributed not a little, notwithstanding the smallness of their number, to raise the spirits of the whole army. They had submitted to the capitulation with the greatest reluctance; but as the Austrians were conducting them to prison, they happened to receive intelligence of the victory at Rosbach: on which they immediately rose on the escort that conducted them, and entirely dispersed it; and afterwards marching in such a direction as they thought might most readily lead them to their king, they accidentally fell in with his army.

His Prussian majesty now approached Breslau; on which the Austrians, confiding in their superiority, (for they exceeded 70,000, while the Prussians scarce amounted to 36,000), abandoned their strong camp, the same which the prince of Bevern had formerly occupied, and advanced to give him battle. The king did not intend by any means to disappoint them, but advanced on his part with the greatest celerity. The two armies met on December 5th, near the village of Leuthen. Count Daun made the best dispositions possible. The ground occupied by his army was a plain, with small eminences in some parts. These eminences they surrounded with artillery; and as the ground was also interspersed with thickets, they sought to turn these likewise to their advantage. On their right and left were hills, on which they planted batteries of cannon. The ground in their front was intersected by many causeways; and to make the whole more impracticable, the Austrians had felled a great number of trees, and scattered them in the way. It was almost

impossible at the beginning of the engagement for the Prussian cavalry to act, on account of these impediments; but, by a judicious disposition made by the king himself, all difficulties were overcome. His majesty had placed four battalions behind the cavalry of his right wing; foreseeing that General Nadasti, who was placed on the enemy's left with a corps de reserve, designed to attack him in flank. It happened as he had foreseen: that general's cavalry attacked the Prussian right wing with great fury; but he was received with such a severe fire from the four battalions, that he was obliged to retire in disorder. The king's flank then, well covered and supported, was enabled to act with such order and vigour as repulsed the enemy. The Austrian artillery was also silenced by that of the Prussians; however, the Austrians continued to make a gallant resistance during the whole battle. After having been once thrown into disorder, they rallied all their forces about Leuthen, which was defended on every side by entrenchments and redoubts. The Prussians attacked them with the utmost impetuosity, and at last became masters of the post; on which the enemy fled on all sides, and a total rout ensued. In this battle the Austrians lost 6000 killed on the spot, 15,000 taken prisoners, and upwards of 200 pieces of cannon.

The consequences of this victory were very great. Breslau³⁶ was immediately invested, and surrendered on^{Prussia re-} December 29th; the garrison, amounting to 13,000 men, were made prisoners of war. The blockade of Schweidnitz was formed as closely as the season of the year would permit; while detached Prussian parties over-ran the whole country of Silesia, and reduced every place of less importance. The Russians, who had ravaged and destroyed the country in such a manner that they could not subsist in it, thought proper to retire out of the Prussian dominions altogether. Thus Ge-³⁷neral Lehwald was left at liberty to act against the^{Swedes} Swedes; and then he quickly drove out of Prussian^{driven out} Pomerania, the whole of which country he not only^{of Pomer-} recovered, but also some part of Swedish Pomerania.^{nia.} Thus the duchy of Mecklenburg being left quite exposed, the king took ample vengeance on it by exacting the most severe contributions of men and money. To complete this monarch's good fortune also, the French, who had retired after the battle of Rosbach, were now opposed by the Hanoverians under Prince Ferdinand, who kept them so well employed, that, during the rest of the war, the king of Prussia had no more trouble from them. See BRITAIN, n° 442.

The beginning of the year 1758 was favourable to Schweid-³⁸ the arms of his Prussian majesty. On the 3d of April^{nitz re-} he commenced his operations against Schweidnitz, and^{taken.} pushed the siege so vigorously, that the place surrendered in 13 days. He then disposed his forces in such a manner as might best guard his dominions against his numerous enemies. For this purpose count Dohna commanded a body of troops on the side of Pomerania; another considerable body was posted between Wohlau and Glogau, in order to cover Silesia from the Russians, in case they should make their inroad that way. An army, in a little time after, was formed in Saxony, commanded by the king's brother Prince Henry. This army consisted of 3 battalions and 45 squadrons, and was designed to make head against the army of the empire; which, by great ef-

Prussia.

59
The king
besieges
Olmütz
without
success.

forts made during the winter, and the junction of a large body of Austrians, was again in a condition to act. Between all these armies a ready communication was kept up by a proper choice of posts. After the reduction of Schweidnitz, the king having made a show of invading Bohemia, suddenly burst into Moravia, where in a short time he made himself master of the whole country, and on the 27th of May laid siege to Olmutz the capital. Of this M. Daun was no sooner informed, than he took his route to Moravia through Bohemia: and, though he was not in a condition to risk a battle, nor indeed would have done so unless he had had a very considerable advantage; yet, by placing himself in a strong situation where he could not be attacked, by harassing the king's troops and cutting off their convoys, he at last obliged him to abandon the enterprise. The king, however, who frequently owed a good part of his success to the impenetrable secrecy with which he covered all his designs, gave not the least hint of his intention to raise the siege of Olmutz. On the contrary, the very day before the siege was raised, the firing continued as brisk as ever; but in the night (July 1.) the whole army took the road to Bohemia in two columns, and gained an entire march upon the Austrians. Thus, notwithstanding the utmost efforts of his enemies, the Prussian army reached Bohemia with very little molestation. Here he seized upon a large magazine at Lieutomissel; defeated some corps of Austrians who had attempted to interrupt his progress; and arrived at Königgratz, of which he took possession, after driving from it 7000 Austrians who were intrenched there. This city and several other districts he laid under contribution: but soon after entered Silesia, and marched with the utmost rapidity to encounter the Russians, who had at that time united their forces under generals Brown and Fermor, entered the New Marche of Brandenburg, and laid siege to Cultrín.

40
The Rus-
sians be-
siege Cu-
Ari-n

The king arrived at this city at a very critical period. The Russians had laid siege to it on the 15th of August; and though they were not well skilled in managing artillery, yet, by furious and unremitting discharges at random, they threw in such a number of bombs and red-hot balls, that the town was soon on fire in every quarter. Some of the wretched inhabitants were burned; others buried in the ruins of their houses, or killed by the balls which fell like hail in the streets; while many of the survivors abandoned their habitations, and fled out of the town on that side where it was not invested. The governor did every thing for the defence of the place; but as the walls were built after the old manner, it was impossible that the town could have made a defence for any length of time, especially as the principal magazine of the besieged had been blown up. The avenger of all these injuries, however, was now at hand. The king came in sight of the Russians on the 25th of August, after a march of 56 days, and beheld the country everywhere desolated, and the villages in flames by the depredations of his cruel enemy, who had raised the siege at his approach, and retired towards a neighbouring village named *Zorndorff*. At nine o'clock in the morning, a most terrible fire of cannon and mortars poured destruction on the right wing of the Russian army for two hours without intermission. The slaughter was such as might

41
But are de-
feated at
Zorndorff

Vol. XV. Part II.

have been expected; but the Russians kept their ground with astonishing resolution, new regiments still pressing forward to supply the places of those that fell. When the first line had fired away all their charges, they rushed forward on the Prussians with their bayonets; and all at once these brave troops, though encouraged by the presence of their king, gave way and fled before an enemy already half defeated. The Russian generals ought now to have attacked with their cavalry the disordered infantry of their enemies, which would have completed the defeat, and in all probability given the finishing stroke to the king of Prussia's affairs. This opportunity, however, they lost: but the king was not so negligent; for, by a very rapid and masterly motion, he brought all the cavalry of his right wing to the centre, and falling on the Russian foot uncovered by their horse, and even disordered by their own success, they pushed them back with most miserable slaughter, at the same time that the repulsed battalions of infantry, returning to the charge, and exasperated at their late disgrace, rendered the victory no longer doubtful. The Russians were now thrown into the most dreadful confusion. The wind blew the dust and smoke into their faces, so that they could not distinguish friends from foes; they fired on each other, plundered their own baggage which stood between the lines, and intoxicated themselves with brandy: the ranks fell in upon one another; and, being thus crammed together into a narrow space, the fire of the Prussians had a full and dreadful effect, while their enemies kept up only a scattered and ineffectual fire, generally quite over their heads. Yet even in this dismal situation the Russians did not fly; but suffered themselves to be slaughtered till seven at night, when their generals having caused an attack to be made on the Prussian right wing, the attention of the enemy was drawn to that quarter, and they had time to retire a little from the field of battle to recover their order.

Prussia.

In this engagement, which was called the *battle of Zorndorff*, the Russians lost 21,529 men, while that of the Prussians did not exceed 2000. A vast train of artillery was taken, together with the military chest, and many officers of high rank. The consequence was, that the Russian army retreated as far as Landsberg on the frontiers of Poland, and the king was left at liberty to march with his usual expedition to the relief of prince Henry of Saxony.

The Prince was at this time sorely pressed by M. Operations
Daun. As soon as the king had left Bohemia in the of Count
manner already related, M. Daun, considering that it Daun,
would have been to no purpose to follow him, resolved to turn his arms towards Saxony. Towards that country, therefore, he took his route through Lusatia, by Zittau, Görlitz, and Bautzen. On the 3d of September he invested the strong fortress of Sonnenstein; which unaccountably surrendered, after a single day's resistance, to one of his generals named *Macquire*. He then began to favour the operations of General Laudohn, who had advanced through the Lower Lusatia to the confines of Brandenburg; and, by drawing the attention of the Prussian forces which were left in Silesia to the northward of that duchy, he facilitated the progress of the generals Harsch and De Ville in the southern parts. He then proposed that prince Henry should be attacked by the army of the empire, while that of

4 K

the

Prussia.

43
Rendered
abortive by
the king of
Prussia;

the Austrians should pass the Elbe, and, falling at the same time on the Prussians, second the attack of the Imperialists, and cut off the retreat of their enemies from Dresden. The sudden appearance of the king of Prussia, however, put an end to this plan; general Laudohn abandoned all his conquests in Lower Lusatia, and retired towards M. Daun, while that general himself retired from the neighbourhood of Dresden as far as Zittau. The army of the empire only kept its ground; possessing itself of the strong post at Pirna, formerly mentioned, but did not undertake any thing. As for the Swedes, who had directed their motions by those of the Russians, they no sooner heard of the victory of Zorndorff, than they retreated with much more expedition than they had advanced.

Thus the king of Prussia's affairs seemed to be pretty well retrieved, when by one fatal piece of negligence he was brought to the verge of ruin. M. Daun had possessed himself of an advantageous camp at Stolphen, by which he preserved a communication with the army of the empire. On the other hand, the king of Prussia, having taken possession of an important post at Bantzen, extended his right wing to the village of Hochkirchen, by which he preserved a communication with his brother Prince Henry, protected Brandenburg, and was better situated than he could be anywhere else for throwing succours into Silesia. The two armies kept a watchful eye on the motions of each other; and as the principal aim of M. Daun was to cut off the king's communication with Silesia, and of the king to cut off M. Daun's communication with Bohemia, a battle seemed inevitable, though great danger seemed to await that party who should begin the attack.

44
Who is sur-
prised and
defeated at
Hochkir-
chen.

In this critical posture of affairs, the Austrian general formed a design of attacking the Prussian camp in the night. In what manner he came to surprise such a vigilant enemy, has never been accounted for; but that such a surprise was actually accomplished on the 14th of October, is certain. In the dead of the preceding night, the Austrian army began to march in three columns towards the camp of the king of Prussia: and though the night was exceedingly dark, and they had a considerable way to go, they all arrived at the same time, in safety, without being discovered, and without the least confusion; and at five in the morning began a regular and well-conducted attack. The Prussians were in a moment thrown into confusion; Marshal Keith, one of their best generals, received two musket-balls, and fell dead on the spot. Prince Francis of Brunswick had his head shot off by a cannon-ball as he was mounting his horse; and every thing seemed to announce the total destruction of the army. Still, however, the king preserved his wonderful presence of mind, which indeed he never appears to have lost on any occasion. He ordered some detachments from his left to support his right wing; but the moment that these orders were received, the left itself was furiously attacked. General Ketzow, who commanded in that quarter, repulsed the Austrians with difficulty, and was not able to afford any considerable assistance to the right; which alone was obliged to sustain the weight of the grand attack. The Austrians, in the beginning of the engagement, had driven the Prussians out of the village of Hochkirchen; and as the fate of the day depended on the possession of that post, the hottest dis-

pute was there. The Prussians made three bloody and unsuccessful attacks on the village; on the fourth they carried it; but the Austrians continually pouring in fresh troops, at last drove them out with prodigious slaughter on all sides. The king then ordered a retreat, which was conducted in good order, without being pursued; however, this bloody action cost him 7000 men, together with a great number of cannon. The Austrians computed their own loss at 5000.

His Prussian majesty, having thus happily escaped such imminent danger, took every possible measure to prevent the enemy from gaining any considerable advantage from his defeat. Perceiving that the only advantage they wished to derive from it was to cover the operations of their armies in Silesia, and that he had now nothing to fear on the side of Saxony, he largely reinforced his own army from that of Prince Henry, and hastened into Silesia, in order to raise the siege of Neiss, which had been completely invested on the 4th of October. On the 24th of that month, therefore, he quitted his camp, and, making a great compass, to avoid obstructions from the enemy, arrived in the plains of Gorlitz. A body of the Austrians had in vain attempted to secure this post before him, and some who arrived after him were defeated with the loss of 800 men. From this place the king pursued his march with the utmost diligence; but was followed by general Laudohn, at the head of 24,000 men, who constantly hung on his rear, and harassed his army. The king, however, knowing the importance of his expedition, continued his march without interruption, and suffered his antagonist to obtain many little advantages without molestation. Daun, however, not content with the opposition given by Laudohn, sent a large body of horse and foot by another route to reinforce the generals Karsch and De Ville, who had formed the siege of Neiss and the blockade of Cosel, while he himself passed the Elbe, and advanced towards Dresden.

All these precautions, however, were of little avail. The generals Karsch and De Ville, notwithstanding their reinforcement, no sooner heard of the king of Prussia's approach, than they raised the siege of both places, and retired, leaving behind them a considerable quantity of military stores. The end of the Prussian monarch's march being thus accomplished, he instantly returned by the same way he came, and hastened to the relief of Saxony, the capital of which (Dresden) was in great danger from Marshal Daun. The place was but indifferently fortified, and garrisoned only by 12,000 men; so that it could not promise to hold out long against a numerous and well-appointed army. It was besides commanded by a large suburb, of which, if once the enemy got possession, all defence of the city must then be vain. For this reason M. Schmettau, the Prussian governor, determined to set these suburbs on fire, which was actually done November 10th, with an incredible loss to the inhabitants, as in the suburbs were carried on most of those valuable manufactures which render the city of Dresden remarkable. This disappointed the designs of M. Daun; but, though the action was agreeable to the laws of war, and had been executed with all the caution and humanity of which such an action was capable, yet the Austrians exclaimed against it as a piece of the most unprovoked and wanton cruelty recorded in history.

Prussia.

45
Suburbs of
Dresden
burnt.

Prussia.
46
Saxony oppressed by the king of Prussia.

After the king of Prussia had approached Dresden, all the Austrian armies retired into Bohemia, where they took up their winter-quarters, as the king of Prussia did in Saxony. This unhappy country he said he would now consider as his own by right of conquest. But instead of treating the conquered people as his lawful subjects, he oppressed them in all possible ways, by levying the most severe and exorbitant contributions, surrounding the exchange with soldiers, and confining the merchants in narrow lodgings on straw-beds, till they drew upon their correspondents for such sums as he wanted.

47
Bohemia invaded by Prince Henry.

In 1759, as early as the 23d of February, the Prussians commenced their military operations. General Woberow marched with a body of troops into Poland, where he destroyed several very large magazines belonging to the Russians, and returned into Silesia without any loss on the 18th of April. In the mean time, by some movements of the king of Prussia himself, the greatest part of the Austrian troops had been drawn towards the frontiers of Silesia. Prince Henry immediately took advantage of this opening, and on the 15th of April entered Bohemia with his army divided into two columns. One, commanded by himself, marched towards Peterwade; the other, under general Hulsen, passed by the towns of Passberg and Commottau. That commanded by Prince Henry himself penetrated as far as Loboschutz and Leitmeritz; the enemy flying everywhere before them, and burning or abandoning the vast magazines which they had amassed in these parts. The body under general Hulsen had a more active employment. A strong pass at Passberg was defended by a considerable body of Austrians. General Hulsen, having conducted his cavalry by another way in such a manner as to fall directly on their rear, attacked them in front with his infantry, drove them out of their intrenchments, and totally defeated them with the loss of a great number killed, and 2000 taken prisoners, while that of the Prussians did not exceed 70 in killed and wounded. After this exploit they returned into Saxony, with hostages for the contributions which they had largely exacted during the course of their expedition.

48
A body of Austrians defeated by General Hulsen.

Some other successes obtained by Prince Henry, cleared the country of Franconia of his enemies; but now the approach of the Russians seemed once more to bring the affairs of the king of Prussia to a crisis. Notwithstanding the destruction of their magazines, they had continued to advance into Silesia, where they were opposed by Count Dohna; but as the troops he had with him were very far inferior to his enemies, he found it impossible to do more, at least with any appearance of success, than to observe their motions and harass them on their march. But this was so displeasing to the king, that he disgraced this general, and appointed Wedel to succeed him, with orders to attack the Russians at all events. To enable him, however, in some measure to comply with this desperate order, he sent him some reinforcements, which brought his army up to near 30,000. With these, on the 23d of July 1759, General Wedel attacked 70,000 Russians posted in the most advantageous manner at Zulichau, and defended by a numerous artillery. Though the Prussians marched on to certain destruction and disgrace, they sustained the attack for a long time with

49
Prussians defeated at Zulichau.

unparalleled resolution. At last, however, they gave way, and were obliged to retire with the loss of 4700 killed or taken prisoners, and 3000 wounded.

Prussia.

The consequences of this victory were, that the Russians penetrated into the king's territories, and took possession of the towns of Crossen and Frankfort on the Oder, which made it absolutely necessary for the king to come in person to oppose them. Accordingly, on the 4th of August, he joined Wedel with a considerable body of forces, having left the greatest part of his army in Saxony under Prince Henry. But as Marshal Daun had sent a body of 12,000 horse and 8000 foot under General Laudohn to the assistance of the Russians, the king still found himself unable to fight them; as, with this and some other reinforcements, their army now amounted to upwards of 90,000. He therefore recalled General Finck, whom he had sent into Saxony with 9000 men; but, with all his reinforcements, it was found impossible to augment his army to 50,000 complete. His situation, however, was now so critical, that a battle was unavoidable; and therefore, on the 12th of August, with this inferiority of number, the king attacked his enemies strongly intrenched, and defended by a prodigious number of cannon. In this action, his principal effort was against the left wing of the Russian army. He began the attack, according to custom, with a heavy cannonade; which having produced the desired effect, he attacked that wing with several battalions disposed in columns. The Russian intrenchments were forced with great slaughter, and 72 pieces of cannon were taken. But still there was a defile to be passed, and several redoubts which covered the village of Cunnersdorf to be mastered. These were attacked with the same resolution, and taken one after another. The enemy made another stand at the village, and endeavoured to preserve their ground there by pushing forward several battalions of horse and foot: but this also proved unsuccessful; they were driven from post to post quite to the last redoubts. For upwards of six hours the Prussians were successful, and everywhere broke the enemy with prodigious slaughter; drove them from almost all the ground they had occupied before the battle, took more than half their artillery, and scarce any thing seemed wanting to make the victory complete. In these circumstances, the king wrote the following billet to the queen: "Madam, we have beat the Russians from their intrenchments. In two hours expect to hear of a glorious victory." Of this victory, however, he deprived himself, by an excessive eagerness for conquest. The enemy, defeated almost in every quarter, found their left wing, shattered as it was, to be more entire than any other part of their army. Count Soltikoff, the Russian general, therefore assembled the remains of his right wing, and, gathering as many as he could from his centre, reinforced the left, and made a stand at a redoubt which had been erected on an advantageous eminence in a place called the *Jesus burying-ground*. All the king's generals are said to have been of opinion, that he ought to allow the Russians the peaceable possession of this post. Their army had already suffered so much, that it would have been impossible for them to have attempted any enterprise of consequence after the battle; but their artillery was still numerous, the post very strong, and the Prussian troops greatly fatigued. These reasons for a few mo-

50
The Russians take Crossen and Frankfort on the Oder.

51
King of Prussia defeated by the Russians at Cunnersdorf.

Prussia.

ments had some weight with the king: but the natural impetuosity of his temper getting the better of his reason, he led on his wearied troops again and again; till at last, when their strength was in a manner totally exhausted, they were attacked and utterly routed by the Austrian and Russian cavalry, the former of which had hitherto remained quite inactive, and were therefore quite fresh, and irresistible by the enfeebled Prussians. The night, and the prudent use of some eminences, prevented the total destruction of the army; however, their loss amounted to 20,000 men killed and wounded. The king, when he found the victory totally lost, sent another billet to the queen, expressed in the following manner: "Remove from Berlin with the royal family; let the archives be carried to Potsdam; the town may make conditions with the enemy."

Immediately after this defeat, the king set himself about repairing his losses with the utmost diligence. In a few days every thing was again put in order in his camp. He replaced his artillery from Berlin; recalled General Kliest with 5000 men from Pomerania; detached 6000 from his own army to the defence of Saxony; and with the remainder put himself between the Russians and Great Glogau, covering that city which had been the chief object of their designs; and in short, notwithstanding their victory, obliged them to return to Poland without accomplishing any thing besides the carnage at Cunnerdorff.

The misfortunes of the Prussian monarch, however, were not at an end. Prince Henry indeed, by a most extraordinary and well-conducted march, entered Saxony, which was now totally over-run by the armies of the enemy. At the same time, strong detachments having been sent into that country under generals Finck and Wunsch, the whole was in a short time recovered except Dresden. Towards this place Marshal Daun retired, and in all probability would soon have been obliged to leave Saxony entirely. But the king's impatience could not be satisfied without cutting off his retreat, and forcing him to a battle; for which purpose he sent General Finck with upwards of 12,000 men according to the Prussian account, but 20,000 according to the Austrians, to seize some passes through which M. Daun could only take his route towards Bohemia. This commission was executed with great exactness; but the Prussian general, having probably advanced too far into these defiles, and neglected to preserve a communication with the main army, gave his enemy an opportunity of surrounding him, and at last forcing him and his whole army to surrender prisoners of war. This disaster was soon after followed by another. General Dürcke was posted at the right of the Elbe, opposite to Meissen; but on the approach of a large body of Austrians, they prepared to retreat over the river into a place where they hoped to be more secure. But having been obliged by an hard frost to withdraw their bridge of boats, a thaw supervened, when they attempted to lay a bridge of pontoons, so that they were again obliged to have recourse to their boats. In this situation, their rear-guard was attacked with great fury by the Austrians, and all the soldiers who composed it killed or taken. The loss of the Prussians on this occasion was computed at 3000 men.

The year 1760 showed the Prussian monarch in a more

dangerous situation than he had ever yet experienced. Indeed his affairs now seemed to be altogether desperate. His losses were not to be measured by the number of the killed or prisoners, but by armies destroyed or taken. Forty generals had died or been killed in his service since the beginning of October 1756, exclusive of those who were wounded or taken prisoners. This of itself would have been an irreparable loss, had not the very wars which destroyed these furnished others equally capable of filling their places. But another deficiency, which could not be remedied, still remained.—The king had, by his indefatigable industry and exertions, supplied all the deficiencies of men in his armies, but they were not the same men as before. The hardy veterans, with whom he had originally taken the field, were now no more, and their places were supplied by others who had neither the same experience nor discipline; so that now he was obliged to supply this deficiency by his own genius and heroism.

But whatever abilities the Prussian monarch might possess, and though he undoubtedly exerted them to the utmost, it seemed only to be contending against fate, and his enemies gained still greater and greater advantages. General Laudohn, with whom none but the king himself seems to have been able to cope, by a series of artful movements, drew into a disadvantageous situation M. Fouquet, one of the Prussian generals, with a strong body of forces. Perceiving it impossible for them to escape, Laudohn then made a violent attack on their intrenchments in the dead of the night of June 23d. The Prussians made a gallant defence, but at last were all killed or taken prisoners except about 300. Of the Prussians were killed 4000, and 7000 taken prisoners; 58 pieces of cannon, and a great number of colours, were also lost. The victory, however, was dear bought; for the Austrians lost about 12,000 men in killed and wounded; whom, however, they could better spare than the Prussians, on account of their numbers.—This action was called *the battle of Landshut*.

Baron Laudohn failed not to improve this victory to the utmost. He instantly turned back from Landshut, and fell upon the city of Glatz; which he took in a very short time, with the garrison who defended it, consisting of 2000 men. In this place were found 100 pieces of brass cannon, with immense quantities of provisions and military stores. From thence he marched against Breslau, and immediately invested it. But, in the mean time, the king of Prussia, whose motions had been all this time counteracted by M. Daun in Saxony, marched with his usual rapidity towards Silesia. By this means he drew M. Daun out of Saxony; and indeed the Austrian general used such expedition, that he gained two full days on the king. This was no sooner known to his Prussian majesty, than he returned with the same expedition that he had advanced, and sat down before Dresden. Of this M. Daun soon received intelligence, and returned also. In the mean time, however, the buildings of the city were terribly shattered by the king's cannon and bombs which continually played on it. His endeavours, however, proved ineffectual to reduce it before the arrival of M. Daun. The siege had been begun on the 13th of July, and on the 19th M. Daun appeared within a league of Dresden. The Prussians

Prussia.
53
Desperate
situation of
the king of
Prussia.

54
Prussians
defeated at
Landshut.

55
Glatz taken by the
Austrians.

56
Dresden besieged but
without success by
the king of
Prussia.

52
General
Finck with
12,000
Prussians
surrenders
to the Au-
strians.

Prussia

Prussians then redoubled their efforts. They had that day received reinforcements of heavy cannon and mortars, with which they battered the place incessantly. The cathedral church, New Square, several principal streets, and some palaces, and the noble manufactory of porcelain, were entirely destroyed. The siege was continued till the 22d: but, on the night of the 21st, M. Daun had thrown 16 battalions into the city; which rendered it impossible for the king to continue longer before it with any prospect of success. He therefore raised the siege, and retired without molestation, though there were three considerable armies of the enemy in the neighbourhood. Breslau was fiercely bombarded by Laudohn, but the approach of Prince Henry obliged him to desist from his enterprise on the 5th of August.

But, in the mean time, the fortune of the king seemed likely to be terminated by one fatal stroke. Finding it impossible for him to carry on a defensive war, he marched towards Silesia with such astonishing rapidity, that before the middle of August he had advanced 200 miles, leaving Marshal Daun with his army far behind him. This expedition he undertook in order to engage General Laudohn before he could have time to effect a junction with Daun and Lacy, another Austrian general; which triple union seemed to threaten him with unavoidable destruction at once. This, however, he found it impossible to prevent: and the three armies, when joined, formed a most tremendous line of encampments, extending no less than 30 English miles; at the same time that every one of their posts was strong, and the communication between them easy. The king was strongly encamped at Lignitz; and for several days employed all his military skill in attempting to induce one of the bodies to detach itself from the rest, or to attack them at some disadvantage; but without effect. At last, the Austrian generals, having maturely weighed all circumstances, resolved to attack the king's camp itself, strong as it was; and Marshal Daun, remembering the advantage he had gained at Hochkirchen by an attack in the night-time, resolved to follow the same plan now. The plan therefore was laid in the following manner. The whole army, as soon as it should begin to grow dark, was to march from their several posts to such situations as were marked out for each corps: they were to strike their tents, but yet to keep up the fires in their camps, and to have the drums beat the tattoo as usual, by which means they had a probability of surprising the enemy; or if not, they judged it absolutely impossible for him to escape them, though he should be ever so much on his guard. In what manner the king of Prussia became acquainted with this plan, is not known. His friends attributed it to his own penetration and knowledge of the stratagems of war; the Austrians, to intelligence given him by deserters. But, in whatever way he became acquainted with this design, it is certain that he took the most effectual methods of preventing it. As the Austrian plan was to surround his camp, and this could not be done without the division of their army which he had so long desired, he resolved to intercept one of the parties; and if that should be disabled from acting, he could then more easily deal with the other two. Therefore, in the very evening calculated for

the decisive attack on his camp, he quitted it with the utmost privacy, and took an advantageous post on the road through which General Laudohn was to pass. The nature of this post was such, that at the same time that it stopped the progress of Laudohn in front, Daun would lie under great difficulties if he should attempt his rear; at the same time that, for his further security, the king strengthened the rear with several batteries. As soon as his army was drawn up, he divided it; leaving his right on the ground where it had been formed, to observe Marshal Daun, and to maintain that post; whilst with his left he turned in order to fall on the corps under General Laudohn. In the mean time, that commander, ignorant of the fate which was awaiting him, advanced with the utmost expedition towards the place which had been assigned him, in order to share in the glory of destroying the Prussian monarch; when, at three in the morning, on the 15th of August, a thick fog which covered the ground, suddenly clearing up, discovered, like the opening of a great scene, the dreadful front of the Prussian army regularly embattled, and advantageously posted. Laudohn, though surprised, made the best dispositions that circumstances would admit of, and an obstinate engagement ensued; in which, however, he was at last obliged to yield to the superior skill of his adversary, with the loss of 10,000 killed, wounded, and prisoners, 82 pieces of cannon, and 23 pair of colours.

The victory, though complete, gave but a partial relief to the king of Prussia. The most essential service it did was the preventing of the Russians from joining those enemies which he already had. Count Czernichew had been advancing with 24,000 men, and had even passed the Oder; but was so intimidated by this news, that he instantly repassed that river on the same bridges which he had lately built, even though M. Daun sent him a strong body of troops in order to encourage him to advance. Soon after this battle, the king joined his brother Prince Henry at New Marche; and marched against Daun, who had begun to form the blockade of Schweidnitz, fell upon a corps under General Beck, made two battalions of Croats prisoners, and dispersed the rest, which obliged the enemy to abandon the enterprise they had just undertaken. About the same time, General Hulsen gained a considerable advantage over the Imperial army in Saxony, with very trifling loss on his part, by which he effectually prevented them from cutting off his communication with the city of Torgau.

By these successes the affairs of his Prussian majesty seemed to revive: but there was no end of his enemies. The late manœuvres had drawn him so far into Silesia, that his communication with Brandenburg was almost wholly cut off. The Russian army, which after it had repassed the Oder began to move out of Silesia, sent forward a powerful detachment under Count Czernichew towards the march of Brandenburg. A body of 15,000 Austrians, under the generals Lacy and Brentano, and the whole united body of Austrians and Imperialists which acted in Saxony, began their march in concert with the Russians, and proposed to unite at the gates of Berlin. These armies amounted to 40,000 men. To oppose this formidable power, general Hulsen called to his assistance general Werner, who had been sent with a body of troops into Pomerania.

Prussia.

58

He defeats General Laudohn, and intimates the Russians.

57
Three Austrian generals join their forces against him.

Prussia.

59
Berlin taken by the Austrians and Russians.

Prussia; but, after being joined by him, their united forces were found not to exceed 15,000 or 16,000 men. To attempt a defence of the capital with this force would have been little short of madness; and therefore these commanders were obliged to leave Berlin to its fate; which indeed, considering the barbarity of the Russians and the animosity of the Austrians, seemed to be a dreadful one. However, by the powerful mediation of several foreign ministers, the town obtained terms which were not altogether intolerable; but the magazines, arsenals, and foundries were destroyed, and an immense quantity of military stores seized, with a number of cannon and other arms. The city was first obliged to pay 800,000 guilders, after which a contribution of 1,900,000 crowns was laid on; yet, notwithstanding this, many violences were committed, and the king's palace was plundered and the furniture abused in a scandalous manner.

60
Extreme embarrassment of the king.

The combined armies staid in Berlin only four days; dreading the severe vengeance of the king of Prussia, who they heard was advancing towards that place with great expedition. But so great were the embarrassments which now attended that monarch, that it seemed absolutely beyond human power to retrieve his affairs. The Imperialists, on their return from Berlin, having no army to oppose them, made themselves masters of Leipzig, Torgau, Meissen, and Wirtemberg; in which last city they found the grand magazine of the Prussians immensely stored with provisions, ammunition, &c. M. Stainville also, with a detachment from Broglie the French general's army, laid the city and duchy of Halberstadt under contribution. In Eastern Pomerania, the Russians had besieged Colberg by sea and land. In the Western Pomerania, the Swedes advanced with great celerity, hoping to share in the plunder of Berlin. In Silesia, the king no sooner began his march to the northward, than Laudohn advanced, and laid siege to the important fortress of Cosel; and, to complete this distress and embarrassment, the king himself was attended at every step by Count Daun with a superior army well prepared to take every advantage.

In this desperate situation the king, being joined by his generals Hulsen and prince Eugene of Wittenberg with the corps under their command, advanced up the Elbe, while M. Daun fell back to cover Leipzig and Torgau: but the latter, finding that the Prussians directed their march towards the Elbe, encamped within reach of Torgau; one part of his army extending to the Elbe, by which he was covered on that side, whilst on the other he was covered by hills and woods, so that it was impossible to choose a more advantageous situation. The Prussian army did not amount to 50,000 men, whilst that of the Austrians exceeded 86,000: yet such were the unfortunate circumstances of the king, that he was obliged to fight under all these disadvantages; and therefore he caused his army to be informed, that he was now to lead them to a most desperate attempt, that his affairs required it, and that he was determined to conquer or die. His soldiers unanimously declared that they would die with him.

61
He defeats Count Daun at Torgau.

The 3d of November 1760 was the day on which this important affair was decided. The king divided his forces into three columns. General Hulsen was to take post with one in a wood that lay on the left of the Austrian army, and had orders not to move until he

found the rest of the Prussians engaged. General Zieten was to charge on the right; and the great attack in front was to be conducted by the king in person. His forces were disposed in such a manner, that either his right or left must take the enemy in rear and close them in, so as to disable them from undertaking any thing against the part where he intended to effect his principal attack. On the other hand, M. Daun perceiving the king to be serious in his design of fighting, to prevent confusion, sent all his baggage over the Elbe, across which he threw three bridges in case a retreat should be necessary. At the same time he caused Torgau to be evacuated; and then, extending his first line to a village called Zinne on the left, he stretched it to another called Groschwitz on the right; supporting the right of his second line upon the Elbe. In this disposition he was found, when, about two o'clock in the afternoon, the king began his attack. He was received by the fire of 200 pieces of cannon, which were disposed along the Austrian front. The Prussians were thrice led on to the attack; but were every time repulsed and broken with terrible slaughter. The king at length commanded a fresh body of cavalry to advance, which at first compelled the Austrians to retire; but new reinforcements continually coming in, this cavalry was in its turn obliged to fall back, and the Prussians maintained themselves with extreme difficulty, until General Zieten, with the right wing, attacked the enemy in the rear, repulsed them, and possessed himself of some eminences which commanded the whole Austrian army. Encouraged by this success, the Prussian infantry once more advanced, mastered several of the enemy's intrenchments, and made way for a new attack of their cavalry, which broke in with irresistible fury on the Austrians, and threw several bodies of them into irreparable disorder. It was now about 9 o'clock, and of consequence both armies were involved in thick darkness; yet the fire continued without intermission, and the battalions with a blind rage discharged at one another without distinguishing friend from foe. M. Daun received a dangerous wound in the thigh, and was carried from the field, which probably hastened the defeat of his troops. The command then devolved on Count O'Donnell; who, finding the greatest part of his troops in disorder, the night advanced, and the enemy possessed of some eminences which commanded his camp, and from which it was in vain to think of driving them, ordered a retreat, which was conducted with wonderful order and exactness; none were lost in passing the bridges, and by far the greater part of their artillery was preserved. The loss of the Prussians was estimated at 10,000 killed and wounded, and 3000 taken prisoners. That of the Austrians in killed and wounded is not known; but 8000 were taken prisoners, with 216 officers, among whom were four generals.

The consequence of the victory of Torgau was, that the king recovered all Saxony except Dresden; and in the mean time General Werner having marched into Pomerania, the Russians raised the siege of Colberg, and retired into Poland, without having effected any thing further than wasting the open country. Werner then flew to the assistance of Western Pomerania, where he defeated a body of Swedes, and at last drove them totally out of the country. General Laudohn too abruptly raised the blockade of Cosel; and afterwards, abandoning

Prussia.

62

All Saxs
only except
Dresden
recovered.

Prussia.

abandoning Landshut, he retired into the Austrian Silesia, leaving the Prussian part entirely in quiet. M. Daun placed one part of his army in Dresden, and the other in some strong posts which lie to the south and west of it, by which he commanded the Elbe, and preserved his communication with Bohemia. The army of the empire retired into Franconia, and placed its headquarters at Bamberg.

Though these successes had, to appearance, retrieved the king's affairs in some measure, yet his strength seemed now to be wholly exhausted; and in the campaign of 1761, he made no such vigorous efforts as he had formerly done. The Russians, dividing themselves into two bodies, invaded Silesia and Pomerania. In the former country they laid siege to Breslau, and in the latter to Colberg. Tottleben also, who had commanded the Russian armies, was now removed on a suspicion that he had corresponded with the king of Prussia, and general Romanzow put in his place; by which it was expected that the Russian operations would be more brisk this year than formerly.

The king continued strongly encamped near Schweidnitz; where he was so closely watched by generals Daun and Laudohn, that he could attempt nothing. However, he defeated the designs of the Russians against Breslau, by sending general Platen to destroy their magazines; which he accomplished with great success, at the same time cutting off a body of 4000 of their troops. But this only brought the more sure destruction upon Colberg; to which place that body of Russians immediately marched, cruelly wasting the country as they went along. The king of Prussia could do nothing but send detachments of small parties, which, though they could not oppose their enemies in the field; yet he hoped, by cutting off the convoys of the enemy, might distress them to such a degree as to oblige them to abandon the siege, or at least protract it till the severity of the winter should render it impossible for them to carry on their operations. Thus he weakened his own army so much, that it was found requisite to draw 4000 men out of Schweidnitz in order to reinforce it; and no sooner was this done, than general Laudohn suddenly attacked and took that fortress by a coup de main. Colberg made a brave defence; but the troops sent to its relief being totally unable to cope with the Russian army consisting of 50,000 men, it was obliged to surrender on the 3d of December; and thus the fate of the Prussian monarch seemed to be decided, and almost every part of his dominions lay open to the invaders.

63
Schweid-
nitz and
Colberg re-
taken.

64
Empress of
Russia dies.

In the midst of these gloomy appearances the empress of Russia, the king's most inveterate and inflexible enemy, died on the 2d of January 1762. Her successor, Peter III. instead of being the king's enemy, was his most sanguine friend. As early as the 23d of February, in a memorial delivered to the ministers of the allied courts, he declared, that, "in order to the establishment of peace, he was ready to sacrifice all the conquests made in this war by the arms of Russia, in hopes that the allied courts will on their parts equally prefer the restoration of peace and tranquillity, to the advantages which they might expect from the continuance of the war, but which they cannot obtain but by a continuance of the effusion of human blood."—This address was not so well relished by the allies: however, they were very willing to make peace, provided it was

for their own interest; but they recommended to his attention fidelity to treaties, which constitutes a no less valuable part of the royal character, than humanity and disinterestedness. This answer made no impression on the czar; a suspension of hostilities took place on the 16th of March, which was followed by a treaty of alliance on the 5th of May. In this treaty the czar stipulated nothing in favour of his former confederates; on the contrary, he agreed to join his troops to those of the king of Prussia, in order to act against them. Sweden, which had for a long time acted under the direction of Russian counsels, now followed the example of her mistress, and concluded a peace with Prussia on the 22d of May.

Prussia.

65
Peace be-
tween Rus-
sia, Swe-
den, and
Prussia.

It is not to be supposed that the king of Prussia would remain long inactive after such an unexpected turn in his favour. His arms were now everywhere attended with success. Prince Henry drove the Imperialists from some important posts in Saxony, by which he secured all that part which the Prussians possessed; and though the Austrians frequently attempted to recover these posts, they were constantly repulsed with great slaughter. The king was not joined by his new allies till the latter end of June; after which he drove M. Daun before him to the extremity of Silesia, leaving the town of Schweidnitz entirely uncovered, and which the king immediately prepared to invest. In the mean time different detachments of Prussians, some on the side of Saxony, and others on that of Silesia, penetrated deep into Bohemia, laid many parts of the country under contribution, and spread an universal alarm. A considerable body of Russian irregulars also made an irruption into Bohemia, where they practised on the Austrians the same cruelties which they had long been accustomed to practise on the Prussians.

66
Successes
of the king
of Prussia.

But while the king was thus making the best use of his time, he was all at once threatened with a fatal reverse of fortune by a new revolution in Russia. The emperor was deposed, and his deposition was soon after followed by his death. The empress, who succeeded him, suspected that her husband had been misled by the counsels of his Prussian majesty, against whom, therefore, she entertained a mortal enmity. She could not, however, in the very beginning of her reign, undertake again a war of so much importance as that which had been just concluded. She therefore declared her intention of observing the peace concluded by the late emperor; but, at the same time, of recalling her armies from Silesia, Prussia, and Pomerania; which indeed the unsettled state of the kingdom now made in some degree necessary. At the same time a discovery was made with regard to the king of Prussia himself, which turned the scale greatly in his favour. The Russian senate, flaming with resentment against this monarch, and against their late unfortunate sovereign; and the empress, full of suspicion that the conduct of the latter might have been influenced by the councils of the former, searched eagerly amongst the papers of the late emperor for an elucidation or proofs of this point. They found indeed many letters from the Prussian monarch; but in a strain absolutely different from what they had expected. The king had, as far as prudence would permit, kept a reserve and distance with regard to the too rash advances of this unhappy ally; and, in particular, counselled him to undertake nothing against

67
A new re-
volution in
Russia.

Prussia.

the empress his consort. The hearing of these letters read is said to have had such an effect upon the empress, that she burst into tears, and expressed her gratitude towards the Prussian monarch in the warmest terms. Still, however, the Russian army was ordered to separate from the Prussians; but all the important places which the former had taken during the whole war were faithfully restored.

The king, finding that the Russians were no more to take an active part in his favour, resolved to profit by their appearance in his camp; and therefore, the very day after the order for their return had arrived, he attacked the Austrian army, and drove their right wing from some eminences and villages where they were advantageously posted; by which means he entirely cut off their communication with Schweidnitz, so that nothing could be attempted for its relief. Prince Henry kept them in continual alarms for Bohemia; and a great part of their attention, and no small part of their forces, were engaged on that side. Marshal Daun, now finding himself rendered almost incapable of undertaking any thing, detached general Laudohn, with a force very much superior, to attack the prince of Bevern, and drive him from the advantageous post he occupied. But the prince defended himself with such resolution, that all the efforts of Laudohn could not succeed before the king had time to come to his assistance. The Austrians, being then put between two fires, were routed and pursued with terrible slaughter; after which, the king met with no more disturbance in his preparations for the siege, and the trenches were opened on the 18th of July. Marshal Daun made no attempts to relieve the place; but the garrison being very strong, it held out for near two months from the opening of the trenches. It is said that the attack was conducted, and the defence made, by two engineers who had written on the subject of the attack and defence of fortified places; and they were now practically engaged to prove the superiority of their systems. At last, however, the garrison, to the number of 8000 men, surrendered prisoners of war; and the whole body, except nine, were soon after drowned at the mouth of the Oder, on their passage to their intended confinement at Königsberg.

The king of Prussia, now become master of Schweidnitz, turned his attention towards Saxony, where he considerably reinforced his brother's army, and made preparations for laying siege to Dresden. In this country the Austrians had lately met with some success, and driven Prince Henry back as far as Freyberg; but on the 29th of October, they were attacked by the Prussian army thus reinforced, and totally routed. Great numbers were slain, and near 6000 taken prisoners. This victory proved decisive: and the empress-queen, finding herself deserted by all her allies, was glad to conclude a treaty; the substance of which was, that a mutual restitution and oblivion should take place, and both parties sit down at the end of the war in the same situation in which they began it. This treaty is called the *peace of Hubertsburg*.

The war was no sooner concluded than the king of Prussia turned his attention to domestic policy, and the recovery of his dominions from those innumerable calamities which had befallen them during the war. He

immediately distributed lands to his disbanded soldiers, and gave them the horses of his artillery to assist them in their cultivation. By his wife and prudent management, the horrors of war were soon forgot; and the country was quickly in as flourishing a state as ever. Notwithstanding this pacific disposition, however, the king never slackened his endeavours for the defence of his country, by keeping a respectable army on foot; which might be able to act on the least emergency.

In the year 1778, a new difference with the house of Austria took place, concerning the duchy of Bavaria. But though the most enormous warlike preparations were made on both sides, and immense armies brought into the field, nothing of consequence was effected. What little advantage there was, seems to have been on the Prussian side, since they made themselves masters of several towns, and kept the war in the enemy's country. However, the emperor acted with so much caution, and showed so much skill in a defensive war, that all the manœuvres of his Prussian majesty could gain no material advantage; as, on the other hand, his adversary was too wise to venture an engagement. A peace therefore was very soon concluded, and since that time the history of Prussia, during the remainder of the great Frederic's reign, affords no remarkable event which we have not mentioned in the life of that hero, and in the article **POLAND**. He left his crown to his nephew, whose character was not then much developed; and it was easily seen that a new kingdom, which had risen suddenly to such unexampled power and greatness as to excite the jealousy or apprehension of all its neighbours, would require great abilities to preserve it from dismemberment.

The late king had indeed bequeathed the most effectual securities to his successor for the preservation of his dominions, that human wisdom could provide or devise; by leaving him a full treasury, the finest army in the world, and a people enthusiastically attached to his memory and government. The new monarch, with these advantages, was not wanting to himself. The late king's predilection for the French language and French literature were not grateful to his subjects. The present sovereign began his reign with declaring in council, "Germans we are, and Germans I mean we shall continue;" giving directions at the same time, that their native language should resume its natural rank and station, from which for near half a century it had been degraded by the French. This was a very popular measure, and it was followed by another still more so. Observing that he had marked with great concern the progress of impiety and profaneness on the one hand, and of enthusiasm on the other, he declared, that he would not have his subjects corrupted either by fanatics or atheists, and strictly prohibited all publications tending to excite a contempt or indifference for religion.

Such, on his immediate accession to the throne, was the pacific conduct of the monarch, which endeared him to his subjects, and commanded the approbation of all good men. An opportunity soon occurred, in which he was thought to have displayed such talents the states of Holland, who had long been jealous of the power of the Stadtholder, and inclined to a republican government without any permanent chief, had gained

Prussia.

70

A new war commences, but produces no memorable event.

71

The great Frederic succeeded by his nephew.

72

State of the nation, and behaviour of the new king.

73

He assists the states of Holland.

68
General
Laudohn
utterly de-
feated.

69
The total
defeat of
the Austri-
ans at
Freyberg
produces a
peace.

Prussia.

ed such an ascendancy in the states general, that in 1786 and 1787 they in effect divested the prince of Orange of all his prerogatives (see *UNITED PROVINCES*). They proceeded even to the seizure and imprisonment of the prince, sister to the king of Prussia; and depending upon support from France, treated with influence every power connected with them in Europe. The court of Berlin did not witness these proceedings without indignation; and the king formed his plan for restoring the power of the Stadtholder with such secrecy and prudence, that perhaps nothing could surpass it but the bravery and military skill of the duke of Brunswick, by whom it was carried into execution. In the short space of one month, that accomplished general led 18,000 Prussians to Amsterdam, and restored the just prerogatives of the prince of Orange. And here, we believe, the friends of the house of Brandenburg will agree with us, that our history of Prussia should conclude. The monarch's subsequent conduct has not been such as the beginning of his reign gave reason to expect. Something of it will be seen under the article *POLAND*, and more under *REVOLUTION* and *UNITED PROVINCES*; and it is not a subject upon which we delight to dwell.

74
Air, soil,
and popu-
lation, of
Prussia.

The air of Prussia is wholesome, and the soil fruitful in grain; affording, besides, plenty of pitcoal and other fuel. The rivers and lakes are well stored with fish; and amber is found on its coast towards the Baltic. The principal rivers are the Vistula, Bregel, Memel, the Passarge, and the Elbe; all of which frequently do damage by their inundations.

The inhabitants of this country were, by Dr Eufching, computed at 635,998 persons capable of bearing arms; and by another German author, at 450,000. Since the year 1719 it is computed that about 34,000 colonists have removed hither from France, Switzerland, and Germany; of which number one half were Saltz-burgers. These emigrants have built 400 small villages, 11 towns, 50 new churches, and founded 1000 village-schools. The manners of the people differ but little from those of the Germans. The established religions are those of Luther and Calvin, but chiefly the former; though almost all other sects are tolerated.

75
Commerce
and manu-
factures.

The late king of Prussia, by the assistance of an excellent police, brought the commerce and manufactures of this country to a very flourishing state, which during his life were daily improving. The manufactures of Prussia consist in glass, iron-work, paper, gunpowder, copper, and brass-mills; manufactures of cloth, camblet, linen, silk, gold and silver lace, stockings, and other articles. The inhabitants export variety of naval stores; amber, lint-seed and hemp-seed, oat-meal, fish, mead, tallow, and caviar; and it is said that 500 ships are loaded with those commodities every year, chiefly from Koningsberg.

76
Constitu-
tion.

His Prussian majesty is absolute through all his dominions; but the late king was too wise to oppress his subjects, though he availed himself to the full of his power. How the present sovereign treats them we know not, as the whole of his conduct for some time past has related to the Polish and French revolutions. The government of this kingdom is by a regency of four chancellors of state, viz. 1. The great-master; 2. The great-burggrave; 3. The great-chancellor; and, 4. The great-marshal. There are also some other coun-

VOL. XV. Part II.

cils, and 37 bailiwicks. The state consists, 1. Of counsellors of state; 2. Of deputies from the nobility; and, 3. From the commons. Besides these institutions, the late king erected a board for commerce and navigation.

Prussia
||
Prussia.

77
Revenues.

His Prussian majesty, by means of the happy situation of his country, its inland navigation, and the excellent regulations of his predecessor, derives an amazing revenue from this country, which, about a century and a half ago, was the seat of boors and barbarism. It is said, that amber alone brings him in 26,000 dollars annually. His other revenues arise from his demesnes, his duties of customs and tolls, and the subsidies yearly granted by the several states; but the exact sum is not known, though we may conclude that it is very considerable, from the immense charges of the late war.

The military regulations introduced by the late king had a wonderfully quick operation in forming his troops and recruiting his armies. Every regiment has a particular district assigned it, where the young men proper for bearing arms are registered; and when occasion offers, they join their regiment, and being incorporated with veterans they soon become well disciplined troops. The Prussian army, in time of peace, consists of 175,000 of the best disciplined troops in the world; and during the last war, that force was augmented to 300,000 men.

78
Military
Strength.

The royal arms of Prussia are argent, an eagle displayed sable, crowned, or, for Prussia: azure, the Imperial sceptre, or, for Courland: argent, an eagle displayed, gules, with semicircular wreaths, for the marquisate of Brandenburg: to these are added the respective arms of the several provinces subject to the Prussian crown.

79
Royal
arms, &c.

There are two orders of knighthood; the first, that of the Black Eagle, instituted by Frederic I. on the day of his coronation at Koningsberg, with this motto, *Suum cuique*. The sovereign is always grand-master; and the number of knights, exclusive of the royal family, is limited to 30. Next to this is the order of Merit, instituted by his late majesty; the motto is, *Pour le merite*.

PRUSSIAN BLUE. See *CHEMISTRY-Index*, at *Colouring Matter* and *Prussian Blue*.

PRUSSIC ACID, according to M. Berthollet, is a combination of azot of hydrogen and carbon. It appears much less akin to acids than to ammoniac; it has, however, too many properties in common with other acids not to place it in the same class, the rather because our classifications are always in a degree arbitrary, and ought to be considered rather as useful methods, than as divisions formed by nature. When the Prussic acid is combined with alkali and oxyd of iron, it cannot be separated by any other acid, unless heat be employed, or it be exposed to light; and nevertheless, when it is disengaged by one of these means, it cannot separate iron, even from the weakest acid, unless it be by a double affinity. It appears that this property is connected with the elastic state, which is unfavourable to these combinations: it must have lost this state, in other words its specific heat must be diminished, in order that it may possess its affinities with metallic oxyds and alkalis. Nitrous gas, oxygenated muriatic acid, and sulphureous acid, present analogous phenomena.

PRYNNE (William), an English lawyer, much distinguished

4 L

Prynne
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Pfalmanazar.

distinguished in the civil commotions under Charles I. was born at Swainwick in Somersetshire in 1600. His *Hijriomaylix*, written against stage-plays in 1632, containing some reflections that offended the court, he was sentenced by the star-chamber to pay a fine of 5000 l. to stand in the pillory, to lose his ears, and to perpetual imprisonment. During his confinement, he wrote several more books; particularly, in 1637, one entitled *News from Ipswich*, which reflecting severely on the bishops, he was again sentenced by the star-chamber to another fine of 5000 l. to lose the remainder of his ears in the pillory, to be branded on both cheeks with S. L. for seditious libeller, and to be perpetually imprisoned in Caernarvon castle. Nothing but cutting off his hands could have prevented Prynne from writing: he wrote still; and in 1640, being set at liberty by the house of commons, he entered London in a kind of triumph, was elected into parliament for Newport in Cornwall, and opposed the bishops with great vigour, being the chief manager of archbishop Laud's trial. In the long parliament he was zealous in the Presbyterian cause; but when the Independents gained the ascendancy, he opposed them warmly, and promoted an agreement with the king. When the army garbled the house and refused him entrance, he became a bitter enemy to them and their leader Cromwell, and attacked them with his pen so severely, that he was again imprisoned: but he pleaded the liberty of the subject so successfully, that he was enlarged, to write more controversial books. Being restored to his seat after Cromwell's death, with the other secluded members, he assisted in promoting the restoration, and was appointed keeper of the Tower records; a place excellently well calculated for him, and where he was very useful by the collections he published from them. He presented 40 volumes of his works, in folio and 4to, to Lincoln's-inn library, of which society he was a member; and, dying in 1669, was buried under the chapel.

PRYTANES, in Grecian antiquity, were the presidents of the senate, whose authority consisted chiefly in assembling the senate; which, for the most part, was done once every day.

The senate consisted of 500, 50 senators being elected out of each tribe: after which, lots were cast, to determine in what order the senators of each tribe should preside; which they did by turns, and during their presidency were called *prytanes*. However, all the 50 prytanes of the tribes did not govern at once, but one at a time, viz. for seven days; and after 35 days, another tribe came into play, and presided for other five weeks; and so of the rest.

PSALM, a divine song or hymn; but chiefly appropriated to the 150 Psalms of David, a canonical book of the Old Testament.

Most of the psalms have a particular title, signifying either the name of the author, the person who was to set it to music or sing it, the instrument that was to be used, or the subject and occasion of it. Some have imagined that David was the sole author of the Book of Psalms; but the titles of many of them prove the contrary, as psalm xix. which appears to have been written by Moses. Many of the psalms are inscribed with the names *Korah*, *Jeduthun*, &c. from the persons who were to sing them.

PSALMANAZAR (George), the fictitious name

of a pretended Formosan, a person of learning and ingenuity. He was born in France, and educated in a free-school, and afterwards in a college of Jesuits, in an archiepiscopal city, the name of which, as likewise those of his birth-place and of his parents, are unknown. Upon leaving the college, he was recommended as a tutor to a young gentleman; but soon fell into a mean rambling life, that involved him in disappointments and misfortunes. His first pretence was that of being a sufferer for religion. He procured a certificate that he was of Irish extraction, that he left that country for the sake of the Catholic faith, and was going on a pilgrimage to Rome. Being unable to purchase a pilgrim's garb, and observing one in a chapel, dedicated to a miraculous saint, which had been set up as a monument of gratitude by some wandering pilgrim, he contrived to take both the staff and cloak away; and, being thus accounted, begged his way in fluent Latin, accosting only clergymen or persons of figure; whom he found so generous and credulous, that, before he had gone 20 miles, he might easily have saved money, and put himself in a much better dress: but as soon as he had got what he thought was sufficient, he begged no more; but viewed every thing worth seeing, and then retired to some inn, where he spent his money as freely as he had obtained it. Having heard the Jesuits speak much of China and Japan, he started the wild scheme, when he was in Germany, of passing for a native of the island of Formosa; and what he wanted in knowledge, he supplied by a pregnant invention. He formed a new character and language on grammatical principles, which, like other oriental languages, he wrote from right to left with great readiness; and planned a new religion, and a division of the year into 20 months, with other novelties, to credit his pretensions. He was now a Japanese convert to Christianity, travelling for instruction, with an appearance more wretched than even that of common beggars. He then entered as a soldier in the Dutch service; but, still desirous of passing for a Japanese, he altered his plan to that of being an unconverted heathen; and at Sluys, brigadier Lauder, a Scots colonel, introduced him to the chaplain, who, with a view of recommending himself to the bishop of London, resolved to carry him over to England. At Rotterdam, some persons having put shrewd questions to him, that carried the air of doubt, he took one more whimsical step, which was to live upon raw flesh, roots, and herbs; which strange food he thought would remove all scruples. The bishop of London patronized him with credulous humanity; and Psalmanazar found a large circle of friends, who extolled him as a prodigy. Yet were there some who entertained a just opinion of him, particularly the Drs Halley, Mead, and Woodward; but their endeavours to expose him as a cheat only made others think the better of him, especially as those gentlemen were esteemed no great admirers of revelation. But in this instance at least, easiness of belief was no great evidence of penetration. He was employed to translate the church-catechism into the Formosan language, which was examined, approved, and laid up as a valuable MS; and the author, after writing his well-known *History of Formosa*, was rewarded and sent to Oxford to study what he liked, while his patrons and opponents were learnedly disputing at London on the merits of his work. The learned members

Pfalmanazar.

Psalmist
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Psatyrians.

members of the university were no better agreed in their opinions than those at London; but at length the sceptics triumphed. Some absurdities were discovered in his history, of such a nature as to discredit the whole narration, and saved him the trouble of an open declaration of his imposture; which however he owned at length to his private friends. For the remainder of his life, his learning and ingenuity enabled him to procure a comfortable support by his pen; he being concerned in several works of credit, particularly *The Universal History*. He lived irreproachably for many years, and died in 1763.

PSALMIST, in the church of Rome, one of the lesser ecclesiastical orders; the same with what among us is called *clerk*, *precentor*, or *singer*.

PSALMODY, the art or act of singing psalms. See PSALM.

Psalmody was always esteemed a considerable part of devotion, and usually performed in the standing posture: and as to the manner of pronunciation, the plain song was sometimes used, being a gentle inflection of the voice, not much different from reading, like the chant in cathedrals; at other times more artificial compositions were used, like our anthems.

As to the persons concerned in singing, sometimes a single person sung alone; sometimes the whole assembly joined together, which was the most ancient and general practice. At other times, the psalms were sung alternately, the congregation dividing themselves into two parts, and singing verse about, in their turns. There was also a fourth way of singing, pretty common in the fourth century, which was, when a single person began the verse, and the people joined with him in the close: this was often used for variety, in the same service with alternate psalmody.

The use of musical instruments, in the singing of psalms, seems to be as ancient as psalmody itself; the first psalm we read of being sung to the timbrel, viz. that of Moses and Miriam, after the deliverance of the Israelites from Egypt: and afterwards, musical instruments were in constant use in the temple of Jerusalem. See ORGAN.

PSALTER, the same with the book of psalms. See the article PSALM.

Among the religious in the Popish countries, the term *psalter* is also given to a large chaplet or rosary, consisting of 150 beads, according to the number of psalms in the psalter.

PSALTERY, a musical instrument, much in use among the ancient Hebrews, who called it *nebel*.

We know little or nothing of the precise form of the ancient psaltery. That now in use is a flat instrument, in form of a trapezium or triangle truncated at top: it is strung with 13 wire-chords, set to unison or octave, and mounted on two bridges, on the two sides: it is struck with a plectrum, or little iron rod, and sometimes with a crooked stick. Its chest or body resembles that of a spinet. See NABLUM and Plate CCCXLIV.

PSAMMETICHUS, or PSAMMITICHUS, a renowned conqueror, who, subduing 11 other petty kings of Egypt, became the founder of the kingdom of Egypt, about 670 B. C. He is memorable likewise for taking the city of Azot, after a siege of 29 years; and for discovering the sources of the river Nile. See EGYPT, n° 10.

PSATYRIANS, a sect of Arians, who, in the

council of Antioch, held in the year 360, maintained, that the Son was not like the Father as to will; that he was taken from nothing, or made of nothing; and that in God, generation was not to be distinguished from creation.

PSELLUS (Michael), a learned Christian of the 11th century, was, by birth, a Constantinopolitan of consular rank, and flourished under the emperor Constantine Monomachus. His genius and industry raised him far above the level of his contemporaries; and the female historian Anna Comuena speaks of him as one who had been more indebted for his attainments to his own excellent talent than to the instructions of his preceptors; adding, that having made himself master of all the wisdom of the Greeks and the Chaldeans, he was justly esteemed the most learned man of the age. Thus furnished, he became the chief instructor of the Constantinopolitan youth. He was at the same time the companion and the preceptor of the emperor, who was so captivated by the studies and amusements in which Pselus engaged him, that, according to Zonaras, he neglected the concerns of the empire. The Byzantine historians complain, that the emperor, deluded by the head of the philosophers (the title with which Pselus was honoured), lost the world. Meeting, towards the close of his life, with some disappointment, Pselus retired into a monastery, and soon afterwards died; the time of his death is uncertain. His works, which have been much celebrated, are, Commentaries upon Aristotle's Logic and Physics; a Compendium of Questions and Answers; and an Explanation of the Chaldean Oracles. The two latter works prove him to have been conversant, not only with Grecian, but with Oriental, philosophy.

PSEUDO, from *πῡδω*, a Greek term used in the composition of many words, to denote *false* or *spurious*: as the pseudo-acacia, or bastard acacia; pseudo-fumaria, or bastard-fumitory; pseudo-ruta, or bastard-rue, &c.

We also say, a pseudo-apostle, or false apostle; a pseudo-prophet, or false prophet, &c.

PSEUDO-China. See SMILAX.

PSEUDO-Galena, or Black-Jack. See ZINC, and MINERALOGY, p. 62.

PSEUDO-Tinea, in natural history, the name of a very remarkable species of insect described by M. Reaumur, approaching to the nature of the *tinea*, or *clothes-moth* while in the worm-state, but not making themselves coats of the substance of leaves, cloth, &c. though they form a sort of cases for their defence against a very terrible enemy.

These creatures are of the caterpillar kind, and have, in the manner of many of these insects, 16 legs. They feed on wax, and for food enter the bee-hives; where they boldly engage the bees, and are not to be prevented by them from feeding, though at the expence of their habitations and the cells of their reservoirs of honey: so that it is no uncommon thing for a swarm of bees to be forced to change their place of habitation, and make new combs elsewhere; leaving the old ones to this contemptible victor, whom they know not how to drive out or dispossess.

Virgil and Aristotle, and all the authors who have written on bees, have complained of this destructive animal. It never eats the honey, but feeds only on the wax; attacking principally those waxy cells where

Pselus,
Pseudo.

Enfield's
History of
Philosophy.

Pseudo. the female bee deposits her eggs for the future progeny.

The bees, who are a match for most other creatures by means of their stings, would easily destroy these weak creatures, were it not for the impervious armour they are covered with. They form themselves a coat of armour of a double matter. The first, which immediately covers the body, is of a kind of silk of their own spinning; and the outer covering over this is of the bees-wax: this is laid considerably thick; and the creature, just thrusting out its head to feed, goes on devouring the cells undisturbed, while a whole army of the inhabitants are in vain buzzing about him, and attempting to pierce him with their stings. He never forsakes his covering, but lengthens and enlarges it as he goes; and gnawing down the sides of the cells in his march, without staying to eat them one by one, the havoc and destruction he occasions are scarce to be conceived. When the time of the change of this creature approaches, it contracts its body within its double covering, and there changes into the nymph state; whence, after a proper time, it comes forth in form of a moth, with granulated horns and a crooked proboscis.

The bees have cunning enough to know their destructive enemy in this new form; and as this is a weak and defenceless state, they attack and destroy all the moths of this species they can meet with. They seldom are so fortunate, however, as to kill the whole race as soon as produced; and if only one escapes, it is able to lay a foundation of revenge for the death of its brethren. All the flies of the moth kind lay a vast number of eggs, and this is behind hand with none of them in that particular: the young ones produced from the eggs of one surviving female of this species are sufficient to destroy many honey-combs; nay, many hives of them. The moth produced by this caterpillar flies but little; yet it is very nimble in avoiding danger, by running, which it does with great swiftness.

There is a species of these pseudo-tineæ, or wax-eating caterpillars, which infest the subterraneous hives of wasps and other creatures which make wax: the manner of living, feeding, and defending themselves from their enemies, is the same in all the species. These last, if they are at any time distressed for food, will eat their own dung; the wax having passed almost unaltered through their bodies, and being still wax, and capable of affording them more nourishment on a second digestion. These species, though they naturally live on this soft food, yet if by any accident they meet with harder only, they know how to live upon it; and can eat a way into the covers and leaves of books, and make themselves cases and coverings of the fragments of these substances. The accurate author† of these observations describes also a kind of *pseudo-tinea* which feeds on wool, and another that eats leather; both making themselves houses also of the materials they feed on.

There is also another kind very destructive to corn: these make themselves a covering by fastening together a great number of the grains, and there living and eating in secret. All these creatures, whatever be their food or habitation, finally become *phaleræ*, or moths; and may be distinguished, even in this state, from the other species, by having granulated horns of a remarkable structure, and all of them a proboscis, or trunk, more or less incurvated.

PSEUDONYMUS, among critics, an author who publishes a book under a false or feigned name; as *cryptonymus* is given to him who publishes one under a disguised name, and *anonymous* to him who publishes without any name at all.

Pseudonymus
||
Psittacus.

PSIDIUM, the GUAVA: A genus of the monogynia order, belonging to the icofandria class of plants; and in the natural method ranking under the 19th order, *Hesperideæ*. The calyx is quinquefid, superior; there are five petals; the berry is unilocular and monospermous. There are two species: 1. The pyrifera, or white guava; 2. The pomifera, or red guava. Both these are thought to be only varieties of the same plant. The red guava rises to the height of 20 feet, and is covered with a smooth bark; the branches are angular, covered with oval leaves, having a strong midrib, and many veins running towards the sides, of a light green colour, standing opposite upon very short footstalks. From the wings of the leaves the flowers come out upon footstalks an inch and an half long: they are composed of five large roundish concave petals, within which are a great number of stamina shorter than the petals, and tipped with pale yellow tops. After the flower is past, the germen becomes a large oval fruit shaped like a pomegranate.

A decoction of the roots of guava is employed with success in dysenteries: a bath of a decoction of the leaves is said to cure the itch and other cutaneous eruptions. Guayava, or guava, is distinguished from the colour of the pulp, into the two species above-mentioned, the white and the red; and, from the figure of the fruit, into the round, and the pear-fashioned or perfumed guava. The latter has a thicker rind, and a more delicate taste than the other. The fruit is about the bigness of a large tennis-ball; the rind or skin generally of a russet stained with red. The pulp within the thick rind is of an agreeable flavour, and interspersed with a number of small white seeds. The rind, when stewed, is eaten with milk, and preferred to any other stewed fruit. From the same part is made marmalade; and from the whole fruit is prepared the finest jelly in the world. The fruit is very astringent, and nearly of the same quality with the pomegranate; so should be avoided by all who are subject to costiveness. The seeds are so hard as not to be affected by the fermentation in the stomachs of animals; so that when voided with the excrements, they take root, germinate, and produce thriving trees. Whole meadows in the West Indies are covered with guavas, which have been propagated in this manner. The buds of guava, boiled with barley and liquorice, produce an excellent ptisan for diarrhoeas, and even the bloody flux, when not too inveterate. The wood of the tree, employed as fuel, makes a lively, ardent, and lasting fire.

PSITTACUS, or PARROT, in ornithology; a genus belonging to the order of *pica*. The bill in this genus is hooked from the base; and the upper mandible is moveable: the nostrils are round, placed in the base of the bill, which in some species is furnished with a kind of cere: the tongue is broad, and blunt at one end: the head is large, and the crown flat: the legs are short, the toes placed two before and two behind. It might seem a wonder why nature has destined to this, which is not naturally a bird of prey, but feeds on fruits and vegetable substances, the crooked beak

† Reaumur's
History of
Insects.

Psittacus

allotted to the hawk and other carnivorous birds : but the reason seems to be, that the parrot being a heavy bird, and its legs not very fit for service, it climbs up and down trees by the help of this sharp and hooked bill, with which it lays hold of any thing and secures itself before it stirs a foot ; and besides this, it helps itself forward very much, by pulling its body on with this hold.

Of all animals, the parrot and crocodile are the only ones which move the upper jaw ; all creatures else moving the lower only. As some particular animals beside are fond of particular foods, so the parrot loves nothing so much as the seeds of the carthamus, or bastard-saffron ; and eats them without any hurt, though they are a purge when given to other creatures.

Parrots are found almost everywhere within the tropics ; and in their natural state they live on fruits and seeds, though, when tame, they will eat flesh, and even fish.

In the East and West Indies they are very common, and in such warm climates are very brisk and lively ; here, however, they lose much of their vigour. They seldom make nests, but breed like owls in hollow trees ; they lay two eggs. At particular times they fly in very large troops, but still they keep two and two together. This genus consists of infinite variety, not so much owing to mixture of species, however, as might be supposed. They seem to run vastly into one another, so as to appear to be related, though received from different parts of the world ; this, however, may possibly be occasioned by their being carried from one place to another for the sake of sale. This uncertainty of native place has prevented Mr Latham from following Buffon's plan, and ranging them according to the places they are supposed to inhabit ; he divides them therefore into those with *uneven* and those with *even* tails.

Buffon ranges the parrots in two great classes : the first of which comprehends those of the Old Continent, and the second those of the New. The former he subdivides into five families, the Cockatoos, the Parrots, properly so called, the Lories, the long-tailed Paroquets, and the short-tailed ones ; and the latter into six, viz. the Macaos, the Amazonians, the Creeks, the Popinjays, the long-tailed Paroquets, and the short-tailed ones.

Mr Latham has increased the genus from 47 to 163 ; and since the time he wrote his *Index* at least 20 more have been discovered. They are very generally divided into three kinds : 1. The larger, which are as big as a moderate fowl, called *macaos* and *cockatoos* ; these have very long tails. 2. The middle-sized ones, commonly called *parrots*, which have short tails, and are a little larger than a pigeon. And, 3. The small ones, which are called *paroquets*, and have long tails, and are not larger than a lark or blackbird.

1. The *psittacus macao*, or red and blue macao, is red, except the wing quills, which above are blue, below rufous : the scapular feathers are variegated with blue and green : the cheeks are naked and wrinkled. It is about two feet seven inches and a half long, and about as big as a capon. Edwards says, when perfect, it will measure a full yard from bill to tail. It inhabits Brasil, Guiana, and other parts of South America. It was formerly very common in St Domingo, but is now rarely found there. It generally lives in moist woods, especially

such as are planted with a particular kind of palm, perhaps what is called the *macaw* tree. It does not in general learn to speak, and its voice is particularly rough and disagreeable. The flesh is hard, black, and unfavoury, but makes good soup, and is much used by the inhabitants of Cayenne and other places. This species, in common with other parrots, is subject to fits when tamed ; and though it will live for many years though the returns be pretty frequent, it generally falls a victim to that disease at last. The Americans call it *gonzalo*. 2. The *psittacus ararauna*, or blue and yellow macaw, is blue above, and yellow below, and the cheeks are naked, with feathery lines. It is about the same size with the last, and inhabits Jamaica, Guiana, Brasil, and Surinam. 3. The *psittacus severus*, or Brasilian green macaw, is black, with a greenish splendor ; the bill and eyes are reddish, and the legs are yellow. It is about one foot and five inches long, and is common in Jamaica, Guiana, and Brasil. It is however comparatively rare ; but it is extremely beautiful, and of a very amiable and sociable temper when familiar and acquainted ; but it can neither bear strangers nor rivals : its voice is not strong, nor does it articulate very distinctly the word *ara*. See Plate CCCCXVI.

4. The *psittacus aurora*, or yellow amazon, is about 12 inches long, of a green colour, with blue wing quills, and a white front ; its orbits are snowy. It inhabits Mexico or Brasil ; but in all probability the latter, from the one which Salerne saw, and which pronounced Portuguese words. The *psittacus guineensis*, or yellow lory, is about ten inches long, and is an inhabitant of Guinea. The bill is of a black colour ; the cere, the throat, and space about the eyes, are white ; above the eye there is a patch of yellow, and the rest of the head and neck is crimson. The breast is yellow, wing coverts green, and the quills are blue, edged with yellow. Under the wings, belly, thighs, vent, and to the under part of the tail, the colour is white, which last is tipped with red ; the legs are dusky, and the claws black. See Plate CCCCXVI.

5. The *psittacus pullarius*, red-headed Guinea parakeet, or Guinea sparrow, is about five inches and a half long. It inhabits Guinea, and is found in Ethiopia, the East Indies, and the island of Java, and sometimes in Surinam. It is green, with a red front, fulvous tail, black bar, and cinereous orbits. The male of this species is peculiarly affectionate to the female. See Plate CCCCXVI.

In Mr White's *Journal of a Voyage to New South Wales*, we find a description, with excellent engravings, of several species of this extensive genus ; and in Governor Philip's Voyage to the same place, we find descriptions and prints of several of the same species. But the most particular of the later authors are Buffon and Latham, especially the last ; to whose extensive and accurate work we therefore refer our readers for that information which our limits permit us not to give. See his *Synopsis*, vol. i. p. 194—323. See also Buffon, vol. vi. p. 63—245.

PSOAS, in anatomy. See there, *Table of the Muscles*.

PSOPHIA, in ornithology ; a genus belonging to the order *gallinae*. The bill is moderate ; the upper mandible is convex ; the nostrils are oblong, sunk, and pervious ; the tongue is cartilagineous, flat, and fringed

Psittacus

||

Psophia.

Psophia,
Psoralea.

Plate
CCCCXVI

at the end; and the legs are naked a little above the knees. The toes are three before and one behind; the last of which is small, with a round protuberance beneath it, which is at a little distance from the ground. Mr Latham only enumerates two species: 1. *Psophia crepitans*, or gold-breasted trumpeter. Its head and breast are smooth and shining green. By the Spaniards of Maynas it is called *trompetero*, and by the French at Cayenne *agami*, under which last Buffon describes it. It inhabits various parts of South America, Brasil, Guiana, Surinam, &c. but it is most plenty in the Amazons country. It is about 20 inches long, being about the size of a large fowl, and lays eggs rather larger, of a blue green colour. It is met with in the Caribbee islands, where it is called a *pheasant*, and its flesh is reckoned as good as that of a pheasant. The most characteristic and remarkable property of these birds consists in the wonderful noise they make either of themselves, or when urged by the keepers of the *menagerie*. Some have supposed it to proceed from the *anus*, and some from the belly. It is now certain, however, that this noise proceeds from the lungs. See Buffon, vol. iv. p. 390, &c. Another very remarkable circumstance is, that they follow people through the streets, and out of town, and that too even perfect strangers. It is difficult to get rid of them; for if you enter a house, they will wait your return, and again join you, though often after an interval of three hours. "I have sometimes (says M. de la Borde) betaken myself to my heels; but they ran faster, and always got before me; and when I stopped, they stopped also. — I know one (continues he) which invariably follows all the strangers who enter his master's house, accompanies them into the garden, takes as many turns as they do, and attends them back again." 2. *Psophia undulata*, or undulated trumpeter, is about the size of a goose. The upper part of the body is of a pale reddish brown colour, beautifully undulated with black. The head is adorned with a dependent crest. On each side of the neck, beneath the ears, begins a list of black, widening as it descends, and meeting on the lower part before, where the feathers become greatly elongated, and hang loosely down. The under parts are generally white, the legs are of a dusky blue colour, like the bill. It is a native of Africa: Mr Latham's specimen came from Tripoli.

PSORALEA, in botany: A genus of the decandria order, belonging to the diadelphia class of plants; and in the natural method ranking under the 32d order, *Papilionaceæ*. The calyx is powdered, with callos points, and as long as the monospermous legumen. The most remarkable species are, 1. The *primata*, or pinnated *psoralea*, rises with a woody soft stem, branching five or six feet high, pinnated leaves of three or four pair of narrow lobes terminated by an odd one, and at the axillas close-sitting blue flowers with white keels. It is a native of Ethiopia. 2. The *bituminosa*, or bituminous trifoliate *psoralea*, rises with a shrubby stalk, branching sparingly about two or three feet high, with ternate or three-lobed leaves of a bituminous scent, and blue flowers in close heads; it grows in Italy and in France. 3. The *aculeata*, or aculeated prickly *psoralea*, rises with a shrubby branching stem three or four feet high, with ternate leaves, having wedge-shaped lobes, terminating in a recurved sharp point,

and the branches terminated by roundish heads of blue flowers; it grows in Ethiopia. These plants flower here every summer; the first sort greatest part of that season, and the others in July and August; all of which are succeeded by seeds in autumn. Keep them in pots in order for removing into the green-house in winter. They are propagated by seeds, sown in a hot-bed in the spring; and when the plants are two or three inches high, prick them in separate small pots, and gradually harden them to the open air, so as to bear it fully by the end of May or beginning of June. They may also be propagated by cuttings any time in summer, planted in pots, and plunged in a little heat, or covered close with hand-glasses, shaded from the sun, and watered.

PSYCHOTRIA, in botany: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 47th order, *Steilata*. The calyx is quinqueentate, persisting, and crowning the fruit; the corolla is tubulated; the berry globose; with two hemispherical sulcated seeds.

The species are four, viz. 1. *Aspatica*; 2. *Serpens*; 3. *Herbacea*; and, 4. *Emetica*. They are all natives of Jamaica. See *IPECACUANHA*.

PSYLLI, (Strabo, Ptolemy): a people in the south of Cyrenaica, so called from king Psyllus, (Agathargides, quoted by Pliny): almost all overwhelmed by sand driven by a south wind (Herodotus). They had something in their bodies fatal to serpents, and their very smell proved a charm against them, according to Pliny, Lucan, &c.

Though we may justly look upon it as fabulous, that these people had any thing in their bodies different from others; it is, however, certain that there are in Egypt at this day some persons who have a method of handling the most poisonous serpents without any hurt. Of these Mr Hasselquist gives the following account:

"They take the most poisonous vipers with their bare hands, play with them, put them in their bosoms, and use a great many more tricks with them, as I have often seen. I have frequently seen them handle those that were three or four feet long, and of the most horrid sort. I inquired and examined whether they had cut out the vipers poisonous teeth; but I have with my own eyes seen they do not. We may therefore conclude, that there are to this day Psylli in Egypt; but what art they use is not easily known. Some people are very superstitious, and the generality believe this to be done by some supernatural art which they obtain from invisible beings. I do not know whether their power is to be ascribed to good or evil; but I am persuaded that those who undertake it use many superstitions.

"The art of fascinating serpents is a secret amongst the Egyptians. It is worthy the endeavours of all naturalists, and the attention of every traveller, to learn something decisive as to this affair. How ancient this art is among the Africans, may be concluded from the ancient Mari and Psylli, who were from Africa, and daily showed proofs of it at Rome. It is very remarkable that this should be kept a secret for more than 2000 years, being known only to a few, when we have seen how many other secrets have within that time been revealed.

Psychotria,
Psylli.

Pſylli.

vealed. The circumstances relating to the fascination of serpents in Egypt, related to me, were principally, 1. That the art is only known to certain families, who propagate it to their offspring. 2. The person who knows how to fascinate serpents, never meddles with other poisonous animals, such as scorpions, lizards, &c. There are different persons who know how to fascinate these animals; and they again never meddle with serpents. 3. Those that fascinate serpents, eat them both raw and boiled, and even make broth of them, which they eat very commonly amongst them; but in particular, they eat such a dish when they go out to catch them. I have been told, that serpents fried or boiled are frequently eat by the Arabians both in Egypt and Arabia, though they know not how to fascinate them, but catch them either alive or dead. 4. After they have eat their soup, they procure a blessing from their scheik (priest or lawyer), who uses some superstitious ceremonies, and amongst others, spits on them several times with certain gestures. This manner of getting a blessing from the priest is pure superstition, and certainly cannot in the least help to fascinate serpents; but they believe, or will at least persuade others, that the power of fascinating serpents depends upon this circumstance."

Notwithstanding this testimony of Hasselquist, the story of the incantation of serpents, though frequently alluded to in Scripture, has been generally treated as a fable. It is, however, affirmed as a certain truth, both by Mr Bruce and M. Savary. "There is no doubt (says the former of these travellers) of its reality. The Scriptures are full of it. All that have been in Egypt have seen as many different instances as they chose. Some have doubted that it was a trick; and that the animals thus handled had been first trained, and then deprived of their power of hurting; and fond of the discovery, they have rested themselves upon it, without experiment, in the face of all antiquity. But I will not hesitate to aver, that I have seen at Cairo (and this may be seen daily without any trouble or expence), a man who came from the catacombs, where the pits of the mummy birds are kept, who has taken a cerastes with his naked hand from a number of others lying at the bottom of a tub, has put it upon his bare head, covered it with the common red cap he wears, then taken it out, put it in his breast, and tied it about his neck like a necklace; after which it has been applied to a hen, and bit it, which died in a few minutes; and, to complete the experiment, the man has taken it by the neck, and beginning at his tail, has ate it as one would do a carrot or stock of celery, without any seeming repugnance.

"We know from history, that where any country has been remarkably infested with serpents, there the people have been screened by this secret.

"To leave ancient history, I can myself vouch, that all the black people in the kingdom of Sennaar, whether Funge or Nuba, are perfectly armed against the bite of either scorpion or viper. They take the cerastes in their hands at all times, put them in their bosoms, and throw them to one another as children do apples or balls, without having irritated them by this usage so much as to bite. The Arabs have not this secret naturally, but from their infancy they acquire an exemption from the mortal consequences attending the bite

of these animals, by chewing a certain root, and washing themselves (it is not anointing) with an infusion of certain plants in water."

From this account we should be apt to think, that these vipers really *would not* bite any who were thus armed against their poison; especially as he adds, that he "constantly observed, that the viper, however lively before, upon being seized by any of these barbarians, seemed as if taken with sickness and feebleness, frequently shut his eyes, and never turned his mouth towards the arm of the person who held him." Yet in another place, speaking of the activity of the cerastes, he says, "I saw one of them at Cairo, in the house of Julian and Rosa, crawl up the side of a box in which there were many, and there lie still, as if hiding himself, till one of the people who brought them to us came near him; and though in a very disadvantageous posture, sticking as it were perpendicularly to the side of the box, he leaped near the distance of three feet, and fastened between the man's forefinger and thumb, so as to bring the blood. The fellow showed no signs of either pain or fear, and even kept him with us full four hours, without his applying any sort of remedy, or seeming inclined to do so."

It is difficult to see how these two accounts can be reconciled. If those who catch vipers are in danger of being bit by them *after* they are caught, certainly they must be so before, and then the whole relation becomes contradictory. Our author tells us, that these feats were performed *for a season*, by those who were artificially armed against the viper's poison, as well as those who had the exemption naturally; but though put in possession of the drugs, he never had the courage to make the experiment. That he should have made such a dreadful experiment on *himself*, no person in his senses would expect; but it is indeed very surprising, that he did not attempt by means of these medicines to arm some of the brute creatures, of the lives of which he was sufficiently prodigal, against the effects of that deadly poison by which so many of them perished.—As surprising it is, that he did not try what effect the root or its decoction would have upon the serpents themselves; or that though he says he had a small quantity of this extraordinary root by him, he gave neither drawing nor description of it.

Though it is impossible to reconcile the particulars of this account to one another, the general fact of the incantation is confirmed by the testimony of M. Savary. This writer tells us, that he saw at the feast of Sidi Ibrahim, a troop of people, seemingly possessed, with naked arms and a fierce look, holding in their hands enormous serpents, which twined round their body, and endeavoured to escape. These Pſylli, grasping them strongly by the neck, avoided the bite; and notwithstanding their hissing, tore them with their teeth, and ate them alive, while the blood streamed from their mouth.

PTARMIGAN, in ornithology. See TETRAO.

PTELEA, SHRUB-TREFOIL: A genus of the monogynia order, belonging to the tetrandria class of plants; and in the natural method ranking with those of which the order is doubtful. The corolla is tetrapetalous; the calyx quadripartite inferior; the fruit is monospermous, with a roundish membrane in the middle.

Pſylli
||
Ptelea.

Pteris.

The species are, 1. The trifoliata, or Carolina shrub-trefoil, hath a shrubby upright stem, dividing into a branchy head eight or ten feet high, covered with a smooth purplish bark, trifoliate leaves, formed of oval spear-shaped folioles, and the branches terminated by large bunches of greenish-white flowers, succeeded by roundish, bordered capsules. 2. The viscosa, or viscous Indian ptelea, rises with several strong shrubby stems, branching erectly 12 or 15 feet high, having a light brown bark, spear-shaped, stiff, simple leaves, and the branches terminated by clusters of greenish flowers.

The first species is a hardy deciduous shrub, and a proper plant for the shrubbery and other ornamental plantations to increase the variety. It is propagated by seeds, layers, and cuttings.

The second species is a stove-plant, and is propagated commonly by seeds.

PTERIS, in botany; a genus of the order of filices, belonging to the cryptogamia class of plants. The fructifications are in lines under the margin. There are 19 species; the most remarkable is the aquilina, or common female fern. The root of this is viscid, nauseous, and bitterish; and like all the rest of the fern tribe, has a salt, mucilaginous taste. It creeps under the ground in some rich soils to the depth of five or six feet, and is very difficult to be destroyed. Frequent mowing in pasture-grounds, plentiful dunging in arable lands, but, above all, pouring urine upon it, are the most approved methods of killing it. It has, however, many good qualities to counterbalance the few bad ones. Fern cut while green, and left to rot upon the ground, is a good improver of land; for its ashes, if burnt, will yield the double quantity of salt that most other vegetables will.—Fern is also an excellent manure for potatoes; for if buried beneath their roots, it never fails to produce a good crop.—Its astringency is so great, that it is used in many places abroad in dressing and preparing kid and chamois leather.—In several places in the north, the inhabitants mow it green, and, burning it to ashes, make those ashes up into balls, with a little water, which they dry in the sun, and make use of them to wash their linen with instead of soap. In many of the Western Isles the people gain a very considerable profit from the sale of the ashes to soap and glass makers.—In Glen Elg in Invernesshire, and other places, the people thatch their houses with the stalks of this fern, and fasten them down with ropes made either of birch-bark or heath. Sometimes they use the whole plant for the same purpose, but that does not make so durable a covering.—Swine are fond of the roots, especially if boiled in their wash.—In some parts of Normandy we read that the poor have been reduced to the miserable necessity of mixing them with their bread. And in Siberia, and some other northern countries, the inhabitants brew them in their ale, mixing one-third of the roots to two-thirds of malt.—The ancients used the root of this fern, and the whole plant, in decoctions and diet-drinks, in chronic disorders of all kinds, arising from obstructions of the viscera and the spleen. Some of the moderns have given it a high character in the same intentions, but it is rarely used in the present practice. The country people, however, still continue to retain some of its ancient uses; for they give the powder of it to destroy worms, and look upon a bed

of the green plant as a sovereign cure for the rickets in children.

PTEROCARPUS, in botany: A genus of the decandria order, belonging to the diadelphia class of plants; and in the natural method ranking under the 32d order, *Papilionaceæ*. The calyx is quinqueentate, the capsule falcated, filiceous, varicose. The seeds are few and solitary. There are four species, viz. 1. *Draeco*; 2. *Ecastaphyllum*; 3. *Lunatus*; and, 4. *Santalinus*. This last is by some referred to the genus *Santalum*. It is called *red saunders*; and the wood is brought from the East Indies in large billets, of a compact texture, a dull red, almost blackish colour on the outside, and a deep brighter red within. This wood has no manifest smell, and little or no taste. It has been commended as a mild astringent, and a corroborant of the nervous system; but these are qualities that belong only to the yellow fort.

The principal use of red saunders is as a colouring drug; with which intention it is employed in some formulae, particularly in the *tinctura lavendule composita*. It communicates a deep red to rectified spirit, but gives no tinge to aqueous liquors; a small quantity of the resin, extracted by means of spirit, tinges a large one of fresh spirit of an elegant blood-red. There is scarcely any oil, that of lavender excepted, to which it communicates its colour. Geoffroy and others take notice, that the Brazil woods are sometimes substituted for red saunders; and the college of Brussels are in doubt whether all that is sold among them for saunders be not really a wood of that kind. According to the account which they have given, their saunders is certainly the Brazil wood; the distinguishing character of which is, that it imparts its colour to water.

PTEROCOCEUS, in botany, is a species of the genus *Calligonum*. See *CALLIGONUM*.

PTERONIA, in botany: A genus of the polygamia equalis order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, *Compositæ*. The receptacle is full of multipartite bristles; the pappus a little plumy; the calyx imbricated.

PTEROSPERMUM, in botany: A genus of the polyandria order, belonging to the monodelphia class of plants; and in the natural method ranking under the 37th order, *Columniferae*. The calyx is quinquepartite; the corolla consists of five oblong spreading petals. The filaments are about 15, which unite towards the base into a tube. The style is cylindrical; the capsule is oval, woody, and quinquelocular, each of which are bivalved, containing many oblong, compressed, and winged seeds. There is only one species, viz. the *Pentapetes*, a native of the East Indies; the wood of which is very hard, and very like that of the holly-tree.

PTINUS, a genus of insects belonging to the order of coleoptera. The antennæ are filiform: The last or exterior articulations are longer than the others: The thorax is nearly round, without a margin, into which the head is drawn back or received: The feet are made for leaping. The most remarkable species are,

1. The *pectinicornis*. This is produced from a worm that lodges in wood and the trunks of trees, such as the willow, where it makes deep round holes, turns to a winged insect, takes flight, and roosts upon flowers. It is distinguished by its antennæ pectinated on one

side

Pterocarpus
||
Ptinus.

Ptisan
||
Ptolemy.

side, whence it has the name of *feathered*. The elytra and thorax are of a deep clay-coloured brown, the antennæ and legs are of a pale brown.

2. The pertinax. The form of this insect resembles the preceding one, saving that its antennæ are filiform. It is all over of a deep blackish brown colour resembling foot. It attacks household-furniture, clothes, furs, and especially animals dried and preserved in collections of natural history, where it makes great havoc. When caught, this insect bends its legs, draws back its head, and lies as if it was dead till it thinks itself out of danger. It cannot be forced out of this state of inaction either by pricking or tearing: nothing but a strong degree of heat can oblige it to resume its motion and run away. There are many beautiful varieties of this genus; but they in general escape our attention by their minuteness, and living among hay, dried leaves, and divers other dusty matters, where they undergo their metamorphoses. The larvæ of some are found in trunks of decayed trees, in old tables, chairs, &c. See Plate CCCCXVI.

PTISAN, is properly barley decorticated, or deprived of its hulls, by beating in a mortar, as was the ancient practice; though the cooling potion obtained by boiling such barley in water, and afterwards sweetening the liquor with liquorice-root, is what at present goes by the name of *ptisan*; and to render it laxative, some add a little senna or other ingredient of the same intention.

PTOLEMAIC *System of Astronomy*, is that invented by Claudius Ptolemæus. See PTOLEMY (Claudius).

PTOLEMAIS, (anc. geog.); the port of Arsinoë, situated on the west branch of the Nile, which concurs to form the island called *Nomos Heracleotes*, to the south of the vertex of the Delta.

PTOLEMAIS, (Strabo); the largest and most considerable town of the Thebais, or Higher Egypt, and in nothing short of Memphis; governed in the manner of a Greek republic; situated on the west side of the Nile, almost opposite to Coptos. This town, which was built by Ptolemy Philadelphus, is now known by the name of *Ptolometa*. The walls and gates are still entire, and there are a vast number of Greek inscriptions, but only a few columns of the portico remain. There is likewise an Ionic temple, done in the most ancient manner of executing that order, of which Mr Bruce took a drawing, which is preserved in the king's collection.—Another, of Cyrenaica, anciently called *Barce*.—A third of the Troglodytica, surnamed *Epitheras*, from the chase of wild beasts, as elephants: lying in the same parallel with Meroë (Strabo); on the Arabian gulf (Pliny); 4820 stadia to the south of Berenice.—A fourth, of Galilee, anciently called *Aca*, or *Acon*; made a Roman colony under the emperor Claudius (Pliny).—A fifth of Pamphylia; situated near the river Melas, on the borders of Cilicia Aspera.

PTOLEMY (Soter, or Lagus), king of Egypt, a renowned warrior, and an excellent prince: he established an academy at Alexandria, and was himself a man of letters. Died 284 B. C. aged 92.

PTOLEMY (Philadelphus), his second son, succeeded him to the exclusion of Ptolemy Ceraunus. He was renowned as a conqueror, but more revered for his great vir-

Vol. XV. Part II.

tues and political abilities. He established and augmented the famous Alexandrian library, which had been begun by his father. He greatly increased the commerce of Egypt, and granted considerable privileges to the Jews, from whom he obtained a copy of the Old Testament, which he caused to be translated into Greek, and deposited in his library. This is supposed to have been the version called the *Septuagint*. He died 246 years B. C. aged 64.

PTOLEMY (Ceraunus), the elder brother, fled to Seleucus king of Macedon, who received him hospitably; in return for which he assassinated him, and usurped his crown. He then invited Arsinoë, who was his widow and his own sister, to share the government with him; but as soon as he got her in his power, he murdered her and her children. He was at length defeated, killed, and torn limb from limb by the Gauls, 279 B. C.

PTOLEMY (Claudius), a celebrated mathematician and astrologer, was born at Pelusium, and surnamed by the Greeks *Most Divine* and *Most Wise*. He flourished at Alexandria in the second century, under the reigns of Adrian and Marcus Aurelius, about the 138th year before the Christian era. There are still extant his Geography, and several learned works on astronomy. The principal of which are, 1. *The Almagest*; 2. *De Judiciis Astrologicis*; 3. *Planispharium*. His system of the world was for many years adopted by the philosophers and astronomers; but the learned have rejected it for the system of Copernicus. See ASTRONOMY, n° 16.

PTYALISM, in medicine, a salivation, or frequent and copious discharge of saliva. The word is Greek, formed from πτυω "to spit."

PUBERTY, denotes the age at which a person is capable of procreating or begetting children. See MAN, n° 13—18.

PUBERTY, in law, is fixed at the age of 12 in females, and 14 in males; after which they are reckoned to be fit for marriage. But as to crimes and punishments, the age of puberty is fixed at 14 in both sexes.

PUBES, in anatomy, denotes the middle part of the hypogastric region in men or women, lying between the two inguina or groins.

Section of the PUBES. See MIDWIFERY and SIGAULTIAN Operation.

PUBES, in botany, the hair or down on the leaves of some plants. See HAIR.

PUBLICAN, among the Romans, one who farmed the taxes and public revenues.

PUBLICATION, the art of making a thing known to the world, the same with promulgation.

PUBLIUS SYRUS, a Syrian mimic poet, who flourished about 44 years before Christ. He was originally a slave sold to a Roman patrician, called Domitius, who brought him up with great attention, and gave him his freedom when of age. He gained the esteem of the most powerful men at Rome, and reckoned J. Cæsar among his patrons. He soon eclipsed the poet Laberius, whose burlesque compositions were in general esteem. There remains of Publius, a collection of moral sentences, written in iambics, and placed in alphabetical order.

Ptolemy
||
Publius.

Puceron
||
Puffendorf.

OAK-PUCERON, a name given by naturalists to a very remarkable species of animal of the puceron kind. They bury themselves in the clefts of the oak and some other trees, and getting into the crevices, where the bark is a little separated from the wood, they there live at ease, and feed to their fill, without being exposed to their common enemies. They are larger than the other pucerons, the winged ones being nearly as large as a common house fly; and those without wings are also larger than any other species of the same genus. The winged ones are black, and the others of a coffee colour. Their trunk is twice the length of their bodies, and, when walking, it is carried straight along the belly, trailing behind it with the point up. When the creature has a mind to suck a part of the tree that is just before it, it draws up, and shortens the trunk, till it brings it to a proper length and direction; but when it sucks in the common way, it crawls upon the inner surface of the bark, and the turned up end of the trunk, which resembles a tail, fixes itself against the wood that is behind it, or contiguous to its back, and sucks there. The extremity of this trunk holds so fast by the wood, that when it is pulled away, it frequently brings a small piece of the wood away with it.

The ants are as fond of these as of the other species of pucerons, and that for the same reason, not feeding upon them, but on their dung, which is a liquid matter of a sweet taste, and is the natural juice of the tree, very little altered. These creatures are the surest guides where to find this species of puceron; for if we at any time see a number of these crawling up an oak to a certain part, and there creeping into the clefts of the bark, we may be assured that in that place there are quantities of these oak pucerons. The ants are so extremely fond of the juices of the tree, when prepared for them by passing through the body of this animal, that when the puceron has a drop not yet evacuated, but hanging only in part out at the passage, an ant will often seize on it there.

PUCERONS, *Vine-suckers*, or *Plant-lice*. See **APHIS**.

PUDENDA, the parts of generation in both sexes. See **ANATOMY**, n° 107 and 108.

PUERILITY, in discourse, is defined by Longinus to be a thought which, by being too far fetched, becomes flat and insipid. Puerility, he adds, is the common fault of those who affect to say nothing but what is brilliant and extraordinary.

PUFFENDORF (Samuel de) was born in 1631 at Fleh, a little village in Misnia, a province in Upper Saxony; and was son of Elias Puffendorf, minister of that place. After having made great progress in the sciences at Leipzig, he turned his thoughts to the study of the public law, which in Germany consists of the knowledge of the rights of the empire over the princes and states of which it is composed, and those of the princes and states with respect to each other. But though he used his utmost efforts to distinguish himself, he despised those pompous titles which are so much sought for at universities, and never would take the degree of doctor. He accepted the place of governor to the son of Mr Coyet, a Swedish nobleman, who was then ambassador from Sweden to the court of Denmark. For this purpose he went to Copenhagen, but continued not long at ease there; for the war being re-

newed some time after between Denmark and Sweden, Puffendorf he was seized with the whole family of the ambassador. During his confinement, which lasted eight months, as he had no books, and was allowed to see no person, he amused himself by meditating on what he read in Grotius's treatise *De Jure Belli et Pacis*, and the political writings of Mr Hobbes. Out of these he drew up a short system, to which he added some thoughts of his own, and published it at the Hague in 1660, under the title of *Elementa Jurisprudentiæ Universalis*. This recommended him to the elector Palatine, who invited him to the university of Heidelberg, where he founded in his favour a professorship of the law of nature and nations, which was the first of that kind established in Germany. Puffendorf remained at Heidelberg till 1673, when Charles XI. of Sweden gave him an invitation to be professor of the law of nature and nations at Lund; which place the elector Palatine reluctantly allowed him to accept. He went thither the same year; and after that time his reputation greatly increased. Some years after, the king of Sweden sent for him to Stockholm, and made him his historiographer, and one of his counsellors. In 1688, the elector of Brandenburg obtained the consent of his Swedish majesty, that he should come to Berlin, in order to write the history of the elector William the Great; and in 1694 made him a baron. But he died that same year of an inflammation in his feet, occasioned by cutting his nails; having attained his grand climacteric. Of his works, which are numerous, the following are the principal: 1. A Treatise on the Law of Nature and Nations, written in German; of which there is an English translation with Barbeyrac's Notes. 2. An Introduction to the History of the Principal States which at present subsist in Europe; written in German; which has been also translated into English. 3. The History of Sweden, from Gustavus Adolphus's expedition into Germany to the abdication of Queen Christina. 4. The History of Charles Gustavus, two volumes folio, &c.

PUFFIN. See **ALCA**, n° 3.

PUGET (Peter Paul), one of the greatest painters and sculptors France ever produced, though but little noticed by their own writers, was born at Marseilles in 1623. In his youth he was the disciple of Roman, an able sculptor; and then went to Italy, where he studied painting and architecture. In painting he so well imitated the manner of Peter de Cortona, that this painter desired to see him, and entered into a friendship with him. In 1657, a dangerous disorder obliged him to renounce the pencil, and devote himself to sculpture; and his reputation causing him to be invited to Paris, he enjoyed a pension of 1200 crowns, as sculptor and director of the works relating to vessels and galleys. He died at Marseilles in 1695, and has left a number of admirable statues behind him both in France and Italy.

PUGIL, in physic, &c. such a quantity of flowers, seeds, or the like, as may be taken up between the thumb and two fore-fingers. It is reckoned the eighth part of the manipulus or handful.

PULEGIUM, or *Penny-Royal*. See **MENTHA**.

PULEX, the *FLEA*, in zoology, a genus of insects belonging to the order of aptera. It has two eyes,

Puffendorf
||
Pulex.

Pulex. and six feet fitted for leaping; the feelers are like threads; the rostrum is inflected, setaceous, and armed with a sting; and the belly is compressed.

The generation of this familiar vermin affords something very curious, first discovered by Sig. Diacinto Cestore. Fleas bring forth eggs, or nits, which they deposit on animals that afford them a proper food: these eggs being very round and smooth, usually slip straight down; unless detained by the piles, or other inequalities, of the clothes, hairs, &c. Of these eggs are hatched white worms, of a shining pearl colour, which feed on the scurfy substance of the cuticle, the downy matter gathered in the piles of clothes, or other the like substances. In a fortnight they come to a tolerable size, and are very lively and active; and, if at any time disturbed, they suddenly roll themselves into a kind of ball. Soon after this, they come to creep, after the manner of silk-worms, with a very swift motion. When arrived at their size, they hide themselves as much as possible, and spin a silken thread out of their mouth, wherewith they form themselves a small round bag, or case, white within as paper, but without always dirty, and fouled with dust. Here, after a fortnight's rest, the animalcule bursts out, transformed into a perfect flea; leaving its exuviae in the bag. While it remains in the bag, it is milk-white, till the second day before its eruption; when it becomes coloured, grows hard, and gets strength; so that upon its first delivery it springs nimbly away.

The flea, when examined by the microscope, affords a very pleasing object. It is covered all over with black, hard, and shelly scales or plates, which are curiously jointed, and folded over one another in such a manner as to comply with all the nimble motions of the creature. These scales are all curiously polished, and are beset about the edges with short spikes in a very beautiful and regular order. Its neck is finely arched, and much resembles the tail of a lobster: the head also is very extraordinary; for from the snout-part of it there proceed the two fore-legs, and between these is placed the piercer or sucker with which it penetrates the skin to get its food. Its eyes are very large and beautiful, and it has two short horns or feelers. It has four other legs joined all at the breast. These, when it leaps, fold short one within another; and then, exerting their spring all at the same instant, they carry the creature to a surprising distance. The legs have several joints, and are very hairy, and terminate in two long and hooked sharp claws. The piercer or sucker of the flea is lodged between its fore-legs, and includes a couple of darts or lancets; which, after the piercer has made an entrance, are thrust farther into the flesh, to make the blood flow from the adjacent parts, and occasion that round red spot, with a hole in the centre of it, vulgarly called a *flea-bite*. This piercer, its sheath opening side-wise and the two lancets within it, are very difficult to be seen; unless the two fore-legs, between which they are hid, be cut off close to the head: for the flea rarely puts out its piercer, except at the time of feeding, but keeps it folded inwards; and the best way of seeing it is by cutting off first the head, and then the fore-legs, and then it is usually seen thrust out in convulsions.

By keeping fleas in a glass tube corked up at both ends, but so as to admit fresh air, their several ac-

tions may be observed, and particularly their way of coupling, which is performed tail to tail; the female, which is much the larger, standing on the male. They may also be thus seen to lay their eggs, not all at once, but ten or twelve in a day, for several days successively; which eggs will be afterwards found to hatch successively in the same order. The flea may easily be dissected in a drop of water; and by this means the stomach and bowels, with their peristaltic motion, may be discovered very plainly, as also their testes and penis, with the veins and arteries, though minute beyond all conception. Mr Lieuwenhoek affirms also, that he has seen innumerable animalcules, shaped like serpents, in the semen masculinum of a flea. This blood-thirsty insect, which fattens at the expence of the human species, *Barbut's Genera of Insects,* prefers the more delicate skin of women; but preys *p. 339, &c* neither upon epileptic persons, nor upon the dead or dying. It loves to nestle in the fur of dogs, cats, and rats. The nests of river-swallows are sometimes plentifully stored with them.

Fleas are apterous; walk but little, but leap to a height equal to 200 times that of their own body. This amazing motion is performed by means of the elasticity of their feet, the articulations of which are so many springs. Thus it eludes, with surprising agility, the pursuit of the person on whom it riots.—Among the memorabilia of fleas, one, they say, has been seen to draw a small silver piece of ordnance to which it was fastened, the firing of the gun nowise daunting its intrepidity. The owner carried it about in a little box lined with velvet, every now and then placing it on her arm to let it feed; but winter put an end to the being of this martial flea. Another flea that became slave to an Englishman, had, for its daily and easy task, to drag its golden chain and padlock, of the weight of one grain. A third flea served as a thrill-horse to an English artist, who had made an ivory coach and six, that carried a coachman with his dog between his legs, a postilion, two footmen, and four inside riders. At Surat fleas, bugs, and other voracious vermin, are in so great veneration, that they have an hospital endowed, where every night a poor fellow, for hire, suffers himself to be preyed upon. He is fastened naked on a bed, when the feast begins at his expence. In Turkey there is a similar foundation for decayed dogs; an institution less ridiculous than the other. Mercurial ointment, brimstone, a fumigation with the leaves of penny-royal, or fresh-gathered leaves of that plant sewed up in a bag, and laid in the bed, are remedies pointed out as destructive of fleas.

Pulex-Arboreus, in natural history, the name given by Mr Reaumur to a very large genus of small animals. They are a kind of half-winged creatures: they have granulated antennæ; and some of them, in their most perfect state, have complete wings. These are distinguished from the others by the name of *musca-pulex* or the *winged-pulex*.

The several species of these creatures are of different colours: some are brown, others yellow; but the most frequent are green. They all feed upon the leaves of trees, which become withered and curled up on their eroding them; and they are so common, that wherever a leaf of a tree is found curled up, or of a different form from the others, it is highly probable these

Pulex.

animals are on it, or that it is their work. Among trees the willow and the rose are the most infected by them; and among plants, the bean and the poppy. They live a social life, multitudes of males and females being found together. The females are easily distinguished from the males, by their being thicker in the body, and having larger bellies.

It is very wonderful, that of all the known animals of the winged kind, these are the only ones which are viviparous. This is easily seen beyond a possibility of doubt; for, on examining a cluster of them together, it is a common thing to see, by the help of a small magnifier, a female in the act of parturition; and the author* of this account frequently saw the young pulex protruded out, from a passage near the anus of the female, perfectly formed. He had suspected this from the total want of eggs among so numerous a tribe of animals, and from their remarkably speedy propagation, and was thus convinced of it by ocular demonstration.

* Reaumur,
History of
Insects.

They are armed with a tender and flexile proboscis; with which they seize hold of the young shoots of the tree they live upon, twisting the proboscis round it. These creatures are always seen naked and exposed, standing on the outside of the stalks and leaves, and sucking in their juices for nourishment with their proboscis. But there is another species of them, which are alike viviparous, and agree with them in all respects except in their manner of living. These get into the inner substance of the leaves, like the worms called *ascarides*; and feed on the parenchyma, being defended from all injuries by living between the integuments. In this case, the leaves they bury themselves in become scabrous and deformed, and produce a sort of galls: so that Malpighi erred in supposing all the galls of trees to be produced by the animals hatched of the eggs of ichneumon flies; since these animals, which are viviparous, and are of a very different kind from the worms of the ichneumon flies, equally produce them. A female of the species here treated of has been seen to bring forth seven young ones in a day; and thus from residing alone in the tubercles which she had formed on a leaf, she in a little time becomes the mother of a numerous family; each of which raises its own tumour or gall on the leaf, which at first are small and round, and of a beautiful red like kermes.

Such of these as are of the male species have a certain time of rest, in which they lie buried in a silky matter, and afterwards become winged, flying nimbly about; whereas the females never are able to fly, but remain always half-winged. It is to be observed, however, that there is a different species of winged insects frequently found flying about the female pulices, as well as their own males; so that all the small-winged insects about them are not to be thought of their own species. These do not greatly differ in figure; but the one are harmless, and the others have stings, and hurt any part of the body on which they fix.

Pulex Aquaticus auctorum (*monoculus pulex* of Linnaeus), in entymology, is a species of the genus *MONOCULUS*, which see. It is a most curious insect of the size of a flea, and has been noticed by many writers who have examined its parts with accuracy, and is that which, uniting together in vast numbers, occasions the

beautiful red patches which may be observed in a dry summer season on stagnant waters, giving rise to reports of water being turned to blood, and in the minds of the less informed thought to portend dire events. The other species of the same genus collect on waters in a similar way, and occasion a similar appearance, as has been mentioned under the generic name, to which we refer our readers. See also Swammerdam's *Book of Nature*, p. 39.; Baker's *Employment for the Microscope*, p. 32.; Schœffer's *Icon. Inf.*; Sultz. *Inf.* p. 30.; De Seer's *Inf.* vol. 7. &c. where there are also excellent figures of it. We have given a figure of it magnified and drawn from life: The outward form of the body, Swammerdam says, is a kind of square; under the eye there is a sharp beak; on the breast are a kind of arms divided into branches like the boughs of trees, and in the abdomen there is a transparent substance with the legs and tail, and in the hinder part of the body, its legs appear placed as it were on the middle of the back: The eyes are almost close together, and are reticulated; the beak is transparent.

Plate
CCCCXVII.

It appears that insects of this tribe are enabled to bear the extremes of heat and cold: for Ray, in his *Historia Insectorum*, p. 41. observes, that the *pulex fluviatilis* was met with by Mr Willoughby in a hot bath near Vicenza in Italy, the temperature of which was such as to prevent any other living therein; and, on the contrary, O. Fabricius, in his *Fauna Grœlandiæ*, p. 264. mentions the circumstance of the *monoculus pulex* being frequently found under the ice in the stagnant waters of Greenland.

The chogo, or *pulex minimus, cutem penetrans, Americanus* of Catesby, is a very small animal found in warm climates. It is a very troublesome insect, especially to negroes and such as are slovenly or go barefooted. They penetrate the skin, under which they lay a bunch of eggs, which swell to the bigness of a small pea or tare. They are exceedingly painful; and unless great care is used in taking them out, they are dangerous. It is about one-fourth the size of a common flea; the figure is considerably magnified. From the mouth issues a hollow tube like that of a common flea, between a pair of antennæ. It has six jointed legs, and something like a tail. Under it is one of its eggs, which is scarcely visible to the naked eye. These animals are a great nuisance to most parts of America between the tropics. See Sir Hans Sloane's *History of Jamaica*, Introd. p. cxxiv. and vol. ii. p. 191, 192.

Plate.
CCCCXVI.

Pulex-Eaters, a name given by naturalists to a sort of worms frequently found on the leaves of trees, where they devour the animals called *pulices arbori*.

Of these there are several species, which owe their origin to the eggs of different creatures; for there are none of them in their ultimate state in this their time of feeding. According to the different animals whose eggs they are hatched from, these are of different form and structure. Some are hexapodes, or endued with six feet; these belong to the beetle-tribe, and finally change into beetles like the parent animal from whose eggs they sprung. Others have no legs, and are produced from the eggs of flies of various kinds. And, finally, others are genuine caterpillars, though small; but these are the most rare of all.

The two general kinds are the hexapodes, or beetle-worms;

Pulley
||
Pulse.

worms; and the apodes, or fly-worms. The fly which gives origin to the last of these is a four-winged one; and takes care always to deposit her eggs in a place where there are plenty of the pulices, usually on the stalk or young branches of a tree in the midst of large families of them. The worm, as soon as hatched, finds itself in the midst of abundance of food, preying at pleasure on these animals, which are wholly defenceless. The stalks of the elder and woodbine are frequently found covered over with these pulices; and among them there may usually be found one or more of these destroyers feeding at will, sucking in the juices from their bodies, and then throwing away the dry skins. Besides the worms of this four-winged fly, there is one of a two-winged wasp fly, very destructive of these animals.

PULLEY, in mechanics, one of the five mechanical powers. See MECHANICS, p. 739.

PULMO, the LUNGS, in ANATOMY. See there, n° 117.

PULMONARIA, LUNGWORT: A genus of the monogynia order, belonging to the pentandria class of plants; and in the natural method ranking under the 41st order, *Asperifoliae*. The corolla is funnel-shaped, with its throat pervious; the calyx is prismatic and pentagonal. There are several species; of which the most remarkable is the officinalis, common spotted lungwort, or Jerusalem cowslip. This is a native of woods and shady places in Italy and Germany, but has been cultivated in Britain for medicinal use. The leaves are of a green colour, spotted with white; and of a mucilaginous taste, without any smell. They are recommended in phthisis, ulcers of the lungs, &c. but their virtues in these diseases are not warranted by experience.

PULO PINANG. See PRINCE of Wales's Island.

PULP, in pharmacy, the fleshy and succulent parts of fruits extracted by infusion or boiling, and passed through a sieve.

PULPIT, an elevated place in a church, whence sermons are delivered. The French give the same name to a reading-desk.

PULPITUM, in the Grecian and Roman theatres, was a place where the players performed their parts. It was lower than the scena, and higher than the orchestra. It nearly answered to what we call the stage, as distinguished from the pit and galleries.—*Pulpitum* was also a moveable desk or pulpit, from which disputants pronounced their dissertations, and authors recited their works.

PULSE, in the animal economy, denotes the beating or throbbing of the heart and arteries.

No doctrine has been involved in more difficulties than that of pulses; since, in giving a physiological account of them, physicians have espoused quite opposite sentiments; whilst some doubt whether the pulse is owing to the systole or diastole; as also, whether the motion of the heart and arteries is one and the same, for a moment of time.

With regard to motion, the pulses are reckoned only four; great and little, quick and slow. When quickness and greatness are joined together, it becomes violent; and when it is little and slow it is called a *weak pulse*. They are also said to be *frequent* and *rare*, *equal* and *unequal*; but these are not the essential affections

of motion. Frequency and quickness are often confounded with each other. A pulse is said to be *hard* or *soft*, with regard to the artery, according as it is tense, renitent, and hard, or flaccid, soft, and lax: for the disposition of the arteries contributes greatly to the change of the pulse; wherefore it sometimes happens, that the pulse in both arms is not alike, which is very common in a hemiplexy. Add to these a convulsive pulse, which does not proceed from the blood, but from the state of the artery; and is known by a tremulous subsultory motion, and the artery seems to be drawn upwards: this, in acute fevers, is the sign of death; and is said to be the pulse in dying persons, which is likewise generally unequal and intermitting. A *great* pulse shows a more copious afflux of the blood to the heart, and from thence into the arteries; a *little* pulse the contrary.

The pulses of persons differ according to the largeness of the heart and vessels, the quantity and temperature of the blood, the elastic force of the canals; as also with regard to the sex, age, season, air, motion, food, sleep, watchings, and passions of the mind. The pulse is larger and more quick in men than in women; in the bilious and sanguineo-bilious, than in the phlegmatic and melancholic. Those who are lean, with tense fibres and large vessels, have a greater and a stronger pulse, than those that are obese, with lax fibres and small vessels; whence they are more healthy, robust, and apt for labour. In children, the pulse is quick and soft; in adults greater and more violent. In the old, it is commonly great, hard, and slow. Labour, motion, and exercise of the body, increase the circulation of the blood, the excretions, and particularly respiration; rest renders the circulation slow and weak; intense speaking increases the circulation, and consequently renders the pulse large and quick. In watching, the pulse is more evident; in sleep, more slow and languid. After drinking hot things, such as coffee and tea, or hot bath-waters, as well as after meals, the pulse vibrates more quick. But nothing produces a greater change in the pulse than affections of the mind: in terror, it is unequal, small, and contracted; in joy, frequent and great; in anger, quick and hard; in sadness, slow, small, deep, and weak; and in intense study, languid and weak. With regard to the air, when, after the predominancy of a west or south wind, it becomes north or east, the pulse is stronger and larger; as also when the quicksilver rises in the barometer. But when the atmosphere is dense, humid, rainy, with a long south wind; as also where the life is sedentary, the sleep long, and the season autumnal, the pulse is languid and small, and the perspiration decreased. In May it is great, and sometimes violent; in the middle of summer, quick but weak; in the autumn, slow, soft, and weak; in the winter, hard and great. A drastic purge and an emetic render the pulse hard, quick, and weak, with loss of strength; chalybeates, and the bark, render it great and robust, and the complexion lively; volatiles amplify and increase the pulse; acids and nitrous remedies refrigerate the body, and appease the pulse; opiates and the like render it small and weak, and decrease the elasticity of the solids; and poisons render it small, contracted, and hard. When the quantity of the blood is too great, bleeding raises the pulse.

PULSE, is also used for the stroke with which any medium

Pulse

Pulteney, medium is affected by the motion of light, sound, &c. through it.

Pulverization. Sir Isaac Newton demonstrates, that the velocities of the pulses in an elastic fluid medium (whose elasticity is proportionable to its density) are in a ratio compounded of half the ratio of the elastic force directly, and half the ratio of the density inversely; so that in a medium whose elasticity is equal to its density, all pulses will be equally swift.

PULSE, in botany, a term applied to all those grains or seeds which are gathered with the hand; in contradistinction to corn, &c. which are reaped, or mowed: or, It is the seed of the leguminous kind of plants, as beans, vetches, &c. but is by some used for artichokes, asparagus, &c.

PULTENEY (William), the famous opposer of Sir Robert Walpole in parliament, and afterward earl of Bath, was descended from one of the most ancient families in the kingdom, and was born in 1682. Being well qualified in fortune, he early procured a seat in the house of commons, and distinguished himself as a warm partisan against Queen Anne's ministry; whose errors he had sagacity to detect, and spirited eloquence to expose. When King George I. came to the throne, Mr Pulteney was made secretary at war, and soon after cofferer to the king's household; but the good understanding between this gentleman and Sir Robert Walpole, who then acted as prime minister, was interrupted in 1725, on a suspicion that Walpole was desirous of extending the limits of prerogative, and of promoting the interests of Hanover, to the prejudice of those of Britain. His opposition to Sir Robert was indeed carried to such indiscriminate lengths, that some have been of opinion he often acted against measures beneficial to the public, merely from personal motives. It would be impracticable here to trace his parliamentary conduct: so it must suffice to observe in general, that he became so obnoxious to the crown, that in 1731 the king called for the council-book, and with his own hand struck out his name from the list of privy-councillors; a proceeding that only served to inflame his resentment and increase his popularity. Thus he still continued to attack the minister with a severity of eloquence and sarcasm that worried every antagonist; so that Sir Robert was heard to declare, he dreaded that man's tongue more than another man's sword. At length, when Walpole found the place of prime minister no longer tenable, and resigned in 1741, among other promotions Mr Pulteney resumed his place in the privy-council, and was created earl of Bath; a title purchased at the expence of that popularity which afterward he naturally enough affected to contemn. In 1760, toward the close of the war, he published *A Letter to two Great Men*, recommending proper articles to be insisted on in a treaty of peace; which, though the writer was then unknown, was greatly applauded, and went through several impressions. He died in 1764; and as his only son died before him, the title became extinct.

PULVERIZATION, the art of pulverizing, or reducing a dry body into a fine powder; which is performed in friable bodies by pounding or beating them in a mortar, &c.; but to pulverize malleable ones, other methods must be taken. To pulverize lead, or

tin, the method is this: Rub a round wooden box all over the inside with chalk; pour a little of the melted metal nimbly into the box; when shutting the lid, and shaking the box briskly, the metal will be reduced to powder.

PUMEX, the **PUMICE-STONE**, a substance frequently thrown out of volcanoes, though there are many which are never known to throw it out. It is very full of pores and blisters; in consequence of which it is specifically very light, and resembles the frothy slag produced in our iron furnaces. It is of two colours, black and white; the former being that which it has when thrown out of the volcano; the latter, as Cronstedt conjectures, being perhaps faded and bleached. Mr Magellan considers it rather as a volcanic ejection than a volcanic production; and describes it as of a white, reddish-brown, grey, or black colour. It is of a rough and porous consistence, being made up of slender fibres parallel to each other, and very light, so that it swims on water. It strikes fire with steel, though with difficulty, and seems originally to have been an asbestos decomposed by the action of fire; but, on observing the appearance of that glassy slag produced in the iron-furnaces, which entirely resembles the pumice-stone, and is produced from the calcareous fluxes used to promote the fusion of the ore, our author is of opinion that the formation of pumice may be rather attributed to that kind of froth which must be formed at the top of the melted matters in the volcanic crater. An hundred parts, according to Bergman, contain from 6 to 15 of magnesia, with a small proportion of calcareous earth, and the greatest part silica. Another kind of pumice, which seems to be a ferruginous granite altered by fire, has been discovered by Dolomieu at Stromboli.

Pumice-stone is used in some mechanical arts; as for rubbing and smoothing the surface of metals, wood, pasteboard, and stone; for which it is well fitted by reason of its harsh and brittle texture; thus scouring and carrying off the little inequalities from the surfaces just mentioned.

PUMICE-STONE. See the preceding article.

PUMP, an hydraulic machine for raising water by means of the pressure of the atmosphere.

It would be an entertaining and not an uninteresting piece of information to learn the progressive steps by which the ingenuity of man has invented the various methods of raising water. A pump must be considered as the last step of this progress. Common as it is, and overlooked even by the curious, it is a very abstruse and refined invention. Nothing like it has been found in any of the rude nations whom the restless spirit of the Europeans has discovered, either in the new continent of America or the islands of the Pacific Ocean. Nay, it was unknown in the cultivated empire of China at the time of our arrival there by sea; and it is still a rarity everywhere in Asia, in places unfrequented by the Europeans. It does not appear to have been known to the Greeks and Romans in early times; and perhaps it came from Alexandria, where physical and mathematical science was much cultivated by the Greek school under the protection of the Ptolemies. The performances of Ctesibius and Hero are spoken of by Pliny and Vitruvius as curious novelties.

**Pumex
||
Pump.**

Of the invention of pumps.

Pump.

ties (A). It is perhaps not difficult to trace the steps by which those mechanicians were led to the invention. The Egyptian wheel was a common machine all over Asia, and is still in use in the remotest corners, and was brought by the Saracens into Spain, where it is still very common under its ancient name *NORIA*. The Danish missionaries found in a remote village in the kingdom of Siam the immediate offspring of the *noria* (*Lettres Edifiantes et Curieuses*.) It was a wheel turned by an ass, and carrying round, not a string of earthen pots, but a string of wisps of hay, which it drew through a wooden trunk. This rude chain-pump was in frequent use for watering the rice fields. It is highly probable that it is of great antiquity, although we do not recollect its being mentioned by any of the Greek or Roman writers. The Arabs and Indians were nothing less than innovators; and we may suppose with great safety, that what arts we now find among them they possessed in very remote periods. Now the step from this to the pump is but short, though it is nice and refined; and the forcing pump of Ctesibius is the easiest and most natural.

Plate
CCCCXIV.2
Ctesibius's
pump.

Let AB (fig. 1.) be the surface of the water in the well, and D the height where it is to be delivered. Let DC be a long wooden trunk, reaching as deep under water as possible. Let the rope EF be fitted with its knot of hay F. When it is drawn up through the trunk, it will bring up along with it all the water lying between C and A, which will begin to run out by the spout D as soon as the knot gets to G, as far below D as C is below A. All this is very obvious; and it required but little reflection to be assured, that if F was let down again, or pushed down, by a rod instead of a rope, it would again perform the same office. Here is a very simple pump. And if it was ever put in practice, it behoved to show the supporting power of the atmosphere, because the water would not only be lifted by the knot, but would even follow it. The imperfection of this pump behoved to appear at first sight, and to suggest its remedy. By pushing down the knot F, which we shall henceforward call the *piston*, all the force expended in lifting up the water between A and G is thrown away, because it is again let down. A valve G, at the bottom, would prevent this. But then there must be a passage made for the water by a lateral tube KBD (fig. 2.) And if this be also furnished with a valve H, to prevent its losing the water, we have the pump of Ctesibius, as sketched in fig. 2. The valve is the great refinement: but perhaps even this had made its appearance before in the *noria*. For, in the more perfect kinds of these machines, the pots have a stop or valve in their bottom, which hangs open while the

pot descends with its mouth downwards, and then allows it to fill readily in the cistern; whereas, without the valve, it would occasion a double load to the wheel. If we suppose that the valve had made its appearance so early, it is not improbable that the common pump sketched in fig. 3. was as old as that of Ctesibius. For a further description of the pump of Ctesibius as it was used by the ancients, and of those pumps which have been deduced from it and are now in common use, see *HYDROSTATICS* n° 28—32. In this place we shall first give a short description of the chief varieties of these engines, considering them in their simplest form, and we shall explain in very general terms their mode of operation. We shall then give a concise and popular theory of their operation, furnishing principles to direct us in their construction; and we shall conclude with the description of a few peculiarities which may contribute to their improvement or perfection.

There are but two sorts of pumps which essentially differ; and all the varieties that we see are only modifications of these. One of these original pumps has a solid piston; the other has a piston with a perforation and a valve. We usually call the first a *FORCING PUMP*, and the second a *LIFTING* or *SUCKING PUMP*.

Fig. 2. is a sketch of the forcing pump in its most simple form and situation. It consists of a hollow cylinder ACca, called the *WORKING BARREL*, open at both ends, and having a valve G at the bottom, opening upwards. This cylinder is filled by a solid piston EF, covered externally with leather or tow, by which means it fits the box of the cylinder exactly, and allows no water to escape by its sides. There is a pipe KHD, which communicates laterally with this cylinder, and has a valve at some convenient place H, as near as possible to its junction with the cylinder. This valve also opens upwards. This pipe, usually called the *RISEING PIPE*, or *MAIN*, terminates at the place D, where the water must be delivered.

Now suppose this apparatus set into the water, so that the upper end of the cylinder may be under operation. even with the surface of the water AB; the water will open the valve G, and after filling the barrel and lateral pipe, will also open the valve H, and at last stand at an equal height within and without. Now let the piston be put in at the top of the working barrel, and thrust down to K. It will push the water before it. This will shut the valve G, and the water will make its way through the valve H, and fill a part Bb of the rising pipe, equal to the internal capacity of the working barrel. When this downward motion of the piston ceases, the valve H will fall down by its own weight and shut this passage. Now let the piston be drawn up again: The valve H hinders the water in the

(A) In the early Greek writings, it does not appear that the words *ἄνταξις*, *ἄνταξις*, *ἄνταξις*, &c. were used to express any thing like what we call a pump. In all these passages the words either express generally the drawing of water, or, more particularly, the drawing it with a bucket or something similar. *ἄνταξις* which is the primitive, is a drain, sink, or receptacle for collecting scattered water, either for use, or to get rid of it; hence it came to signify the sink or well of a ship; and *ἄνταξις* was synonymous with our verb "to bale the boat." (*Odyss.* O. 476. M. 411. *Euryp. Hecuba*, 1025). *ἄνταξις* is the vessel or bucket with which water is drawn. *ἄνταξις* is the service (generally a punishment) of drawing water. *ἄνταξις*, "to draw water with a bucket": hence the force of Aristotle's expression (*Οἰκον.* 1) *τὸ γὰρ ἡμέω ἄνταξις τοῦτ' ἐστίν*. See even the late authority of the New Testament, John ii. 8; iv. 7. 11. Here *ἄνταγμα* is evidently something which the woman brought along with her; probably a bucket and rope.

Pump.

the rising pipe from returning into the working barrel. But now the valve *G* is opened by the pressure of the external water, and the water enters and fills the cylinder as the piston rises. When the piston has got to the top, let it be thrust down again: The valve *G* will again be shut, and the water will be forced through the passage at *H*, and rise along the main, pushing before it the water already there, and will now have its surface at *L*. Repeating this operation, the water must at last arrive at *D*, however remote, and the next stroke would raise it to *e*; so that during the next rise of the piston the water in *ed* will be running off by the spout.

The effect will be the same whatever is the position of the working barrel, provided only that it be under water. It may lie horizontally or sloping, or it may be with its mouth and piston rod undermost. It is still the same forcing pump, and operates in the same manner and by the same means, viz. the pressure of the surrounding water.

The external force which must be applied to produce this effect is opposed by the pressure exerted by the water on the opposite face of the piston. It is evident, from the common laws of hydrostatics, that this opposing pressure is equal to the weight of a pillar of water, having the face of the piston for its base, and the perpendicular height *dA* of the place of delivery above the surface of the water *AB* in the cistern for its height. The form and dimensions of the rising pipe are indifferent in this respect, because heavy fluids press only in the proportion of their perpendicular height. Observe that it is not *dF*, but *dA*, which measures this pressure, which the moving force must balance and surmount. The whole pressure on the under surface *Ff* of the piston is indeed equal to the weight of the pillar *dFfs*; but part of this is balanced by the water *A Ffa*. If indeed the water does not get into the upper part of the working barrel, this compensation does not obtain. While we draw up the piston, this pressure is removed, because all communication is cut off by the valve *H*, which now bears the whole pressure of the water in the main. Nay, the ascent of the piston is even assisted by the pressure of the surrounding water. It is only during the descent of the piston therefore that the external force is necessary.

Observe that the measure now given of the external force is only what is necessary for balancing the pressure of the water in the rising pipe. But in order that the pump may perform work, it must surmount this pressure, and cause the water to issue at *D* with such a velocity that the required quantity of water may be delivered in a given time. This requires force, even although there were no opposing pressure; which would be the case if the main were horizontal. The water fills it, but it is at rest. In order that a gallon, for instance, may be delivered in a second, the whole water in the horizontal main must be put in motion with a certain velocity. This requires force. We must therefore always distinguish between the state of equilibrium and the state of actual working. It is the equilibrium only that we consider at present; and no more is necessary for understanding the operation of the different species of pumps. The other force is of much more intricate investigation, and will be considered by itself.

The simplest form and situation of the lifting pump is represented by the sketch fig. 3. The pump is immersed in the cistern till both the valve *G* and piston *F* are under the surface *AB* of the surrounding water. By this means the water enters the pump, opening both valves, and finally stands on a level within and without.

Now draw up the piston to the surface *A*. It must lift up the water which is above it (because the valve in the piston remains shut by its own weight); so that its surface will now be at *a*, *Aa* being made equal to *AF*. In the mean time, the pressure of the surrounding water forces it into the working barrel, through the valve *G*; and the barrel is now filled with water. Now, let the piston be pushed down again; the valve *G* immediately shuts by its own weight, and in opposition to the endeavours which the water in the barrel makes to escape this way. This attempt to compress the water in the barrel causes it to open the valve *F* in the piston; or rather, this valve yields to our endeavour to push the piston down through the water in the working barrel. By this means we get the piston to the bottom of the barrel; and it has now above it the whole pillar of water reaching to the height *a*. Drawing up the piston to the surface *A* a second time, must lift this double column along with it, and its surface now will be at *b*. The piston may again be thrust down through the water in the barrel, and again drawn up to the surface; which will raise the water to *c*. Another repetition will raise it to *d*; and it will now show itself at the intended place of delivery. Another repetition will raise it to *e*; and while the piston is now descending to make another stroke, the water in *ed* will be running off through the spout *D*; and thus a stream will be produced, in some degree continual, but very unequal. This is inconvenient in many cases: thus, in a pump for domestic uses, such a hobbling stream would make it very troublesome to fill a bucket. It is therefore usual to terminate the main by a cistern *LMNO*, and to make the spout small. By this means the water brought up by the successive strokes of the piston rises to such a height in this cistern, as to produce an efflux by the spout nearly equable. The smaller we make the spout *D* the more equable will be the stream; for when the piston brings up more water than can be discharged during its descent, some of it remains in the cistern. This, added to the supply of next stroke, makes the water rise higher in the cistern than it did by the preceding stroke. This will cause the efflux to be quicker during the descent of the piston, but perhaps not yet sufficiently quick to discharge the whole supply. It therefore rises higher next stroke; and at last it rises so high, that the increased velocity of efflux makes the discharge precisely balance the supply. Now, the quantity supplied in each stroke is the same, and occupies the same room in the cistern at top; and the surface will sink the same number of inches during the descent of the piston, whether that surface has been high or low at the beginning. But because the velocities of the efflux are as the square roots of the heights of the water above the spout, it is evident that a sink of two or three inches will make a smaller change in the velocity of efflux when this height and velocity are great. This seems but a trifling observation; but it serves to illustrate a thing to be considered afterwards, which is important and abstruse, but perfectly similar to this.

Pump.

It is evident, that the force necessary for this operation must be equal to the weight of the pillar of water $d A a D$, if the pipe be perpendicular. If the pump be standing aslope, the pressure which is to be balanced is still equal to the weight of a pillar of water of this perpendicular height, and having the surface of the piston for its base.

Such is the simplest, and, we may add, by far the best, form of the forcing and lifting pumps; but it is not the most usual. Circumstances of convenience, economy, and more frequently of fancy and habit, have caused the pump-makers to deviate greatly from this form. It is not usual to have the working barrel in the water; this, especially in deep wells, makes it of difficult access for repairs, and requires long piston rods. This would not do in a forcing pump, because they would bend.

7
Effect of
giving the
piston a
longer
stroke.

We have supposed, in our account of the lifting pump, that the rise of the piston always terminated at the surface of the water in the cistern. This we did in order that the barrel might always be filled by the pressure of the surrounding water. But let us suppose that the rise of the piston does not end here, and that it is gradually drawn up to the very top: it is plain that the pressure of the atmosphere is by this means taken off from the water in the pipe (see PNEUMATICS), while it remains pressing on the water of the cistern. It will therefore cause the water to follow the piston as it rises through the pipe, and it will raise it in this way 33 feet at a medium. If, therefore, the spout D is not more than 33 feet above the surface of the water in the cistern, the pipe will be full of water when the piston is at D . Let it be pushed down to the bottom; the water will remain in the pipe, because the valve G will shut: and thus we may give the piston a stroke of any length not exceeding 33 feet. If we raise it higher than this, the water will not follow; but it will remain in the pipe, to be lifted by the piston, after it has been pushed down through it to the bottom.

8
Inconvenient and unnecessary.

But it is not necessary, and would be very inconvenient, to give the piston so long a stroke. The great use of a pump is to render effectual the reciprocation of a short stroke which we can command, while such a long stroke is generally out of our power. Suppose that the piston is pushed down only to b ; it will then have a column $b f$ incumbent on it, and it will lift this column when again drawn up. And this operation may be repeated like the former, when the piston was always under water; for the pressure of the atmosphere will always cause the water to follow the piston to the height of 33 feet.

Nor is it necessary that the fixed valve G be placed at the lower orifice of the pipe, nor even under water. For, while things are in the state now described, the piston drawn up to f , and the whole pipe full of water; if we suppose another valve placed at b above the surface of the cistern, this valve can do no harm. Now let the piston descend, both valves G and b will shut. G may now be removed, and the water will remain supported in the space $b G$ by the air; and now the alternate motions of the piston will produce the same effect as before.

9
Effect of
the weight
of the wa-
ter and
pressure of
the atmo-
sphere.

We found in the former case that the piston was carrying a load equal to the weight of a pillar of water of the height AD , because the surrounding water could only support it at its own level. Let us see what change is produced by the assistance of the pressure of the at-

VOL. XV. Part II.

mosphere. Let the under surface of the piston be at b ; when the piston was at f , 33 feet above the surface of the cistern, the water was raised to that height by the pressure of the atmosphere. Suppose a partition made at b by a thin plate, and all the water above it taken away. Now pierce a hole in this plate. The pressure of the atmosphere was able to carry the whole column $f a$. Part of this column is now removed, and the remainder is not a balance for the air's pressure. This will therefore cause the water to spout up through this hole and rise to f . Therefore the under surface of this plate is pressed up by the contiguous water with a force equal to the weight of that pillar of water which it formerly supported; that is, with a force equal to the weight of the pillar $f b$. Now, the under surface of the piston, when at b , is in the same situation. It is pressed upwards by the water below it, with a force equal to the weight of the column $f b$: But it is pressed downwards by the whole pressure of the atmosphere, which presses on all bodies; that is, with the weight of the pillar $f a$. On the whole, therefore, it is pressed downwards by a force equal to the difference of the weights of the pillars $f a$ and $f b$; that is, by a force equal to the weight of the pillar $b a$.

It may be conceived better perhaps in this way. When the piston was under the surface of the water in the cistern, it was equally pressed on both sides, both by the water and atmosphere. The atmosphere exerted its pressure on it by the intervention of the water; which being, to all sense, a perfect fluid, propagates every external pressure undiminished. When the piston is drawn up above the surface of the pit-water, the atmosphere continues to press on its upper surface with its whole weight, through the intervention of the water which lies above it; and its pressure must therefore be added to that of the incumbent water. It also continues to press on the under surface of the piston by the intervention of the water; that is, it presses this water to the piston. But, in doing this, it carries the weight of this water which it is pressing on the piston. The pressure on the piston therefore is only the excess of the whole pressure of the atmosphere above the weight of the column of water which it is supporting. Therefore the difference of atmospheric pressure on the upper and under surfaces of the piston is precisely equal to the weight of the column of water supported in the pipe by the air. It is not, however, the individual weight of this column that loads the piston; it is the part of the pressure of the atmosphere on its upper surface, which is not balanced by its pressure on the under surface.

In attempting therefore to draw up the piston, we have to surmount this unbalanced part of the pressure of the atmosphere, and also the weight of the water which lies above the piston, and must be lifted by it: and thus the whole opposing pressure is the same as before, namely, the weight of the whole vertical pillar reaching from the surface of the water in the cistern to the place of delivery. Part of this weight is immediately carried by the pressure of the atmosphere; but, in lieu of it, there is an equal part of this pressure of the atmosphere abstracted from the under surface of the piston, while its upper surface sustains its whole pressure.

So far, then, these two states of the pump agree.—Other circumstances to be attended to, and there are some circumstances not very obvious which must be attended to, in order that the pump may deli-

Pump.

10
Other cir-
cumstances
to be at-
tended to.
very

Pump. ver any water at the spout D. This requires, therefore, a serious examination.

Let the fixed valve G (fig. 4.) be supposed at the surface of the cistern water. Let Mm be the lowest, and Nn the highest, positions of the piston, and let $HA=b$ be the height of a column of water equiponderant with the atmosphere.

When the pump is filled, not with water, but with air, and the piston is in its lowest position, and all in equilibrio, the internal air has the same density and elasticity with the external. The space $MAam$, therefore, contains air of the common density and elasticity. These may be measured by b , or the weight of a column of water whose height is b . Now, let the piston be drawn up to Nn . The air which occupied the space $MAam$ now occupies the space $NAan$, and its density is now $\frac{MAam}{NAan}$. Its elasticity is now diminished, being proportionable to its density (see PNEUMATICS), and no longer balances the pressure of the atmosphere. The valve G will therefore be forced up by the water, which will rise to some height SA. Now let the piston again descend to Mm . It cannot do this with its valve shut; for when it comes down so far as to reduce the air again to its common density, it is not yet at M , because the space below it has been diminished by the water which got into the pipe, and is retained there by the valve G. The piston valve, therefore, opens by the air which we thus attempt to compress, and the superfluous air escapes. When the piston has got to M , the air is again of the common density, and occupies the space $MSsm$. Now draw the piston up to N . This air will expand into the space $NSsn$, and its density will be reduced to $\frac{MSsm}{NSsn}$, and its elasticity will no longer balance the pressure of the atmosphere, and more water will enter, and it will rise higher. This will go on continually. But it may happen that the water will never rise so high as to reach the piston, even though not 33 feet above the water in the cistern: For the successive diminutions of density and elasticity are a series of quantities that decrease geometrically, and therefore will have a limit. Let us see what determines this limit.

At whatever height the water stands in the lower part of the pipe, the weight of the column of water $SAas$, together with the remaining elasticity of the air above it, exactly balances the pressure of the atmosphere (see PNEUMATICS, n° 108.) Now the elasticity of the air

in the space $NSsn$ is equal to $b \times \frac{MSsm}{NSsn}$. Therefore, in the case where the limit obtains, and the water rises no farther, we must have $b = AS + b \frac{MSsm}{NSsn}$, or, because the column is of the same diameter throughout, $b = AS + b \frac{MS}{NS}$ and $\frac{MS}{NS} b = b - AS = HS$, and $NS : MS$

$= HA : HS$, and $NS - MS : NS = HA - HS : HA$, or $NM : NS = AS : AH$, and $NM \times AH = NS \times AS$.—Therefore, if AN , the distance of the piston in its highest position from the water in the cistern, and NM the length of its stroke, be given, there is a certain determined height AS to which the water can be raised by the pressure of the air: For AH is a constant quan-

tity; and therefore when MN is given, the rectangle $AS \times SN$ is given. If this height AS be less than that of the piston in its lowest position, the pump will raise no water, although AN may be less than AH . Yet the same pump will raise water very effectually, if it be first of all filled with water; and we have seen professional engineers much puzzled by this capricious failure of their pumps. A little knowledge of the principles would have prevented their disappointment.

To insure the delivery of water by the pump, the stroke must be such that the rectangle $MN \times AH$ may be greater than any rectangle that can be made of the parts of AN , that is, greater than the square of half AN . Or, if the length of the stroke be already fixed by other circumstances, which is a common case, we must make AN so short that the square of its half, measured in feet, shall be less than 33 times the stroke of the piston.

Suppose that the fixed valve, instead of being at the surface of the water in the cistern, is at S , or any where between S and A , the performance of the pump will be the same as before: But if it be placed anywhere above S , it will be very different. Let it be at T . It is plain that when the piston is pushed down from N to M , the valve at T prevents any air from getting down; and therefore, when the piston is drawn up again, the air contained in the space $MTtm$ will expand into the space $NTtn$, and its density will be $\frac{MT}{NT}$. This is less

than $\frac{MS}{NS}$, which expresses the density of the air which was left in the space $TSst$ by the former operations.—The air, therefore, in $TSst$ will also expand, will open the valve, and now the water will rise above S . The proportion of NS to NT may evidently be such that the water will even get above the valve T . This diminishes the space $NTtn$; and therefore, when the piston has been pushed down to M , and again drawn up to N , the air will be still more rarefied, and the water will rise still higher. The foregoing reasoning, however, is sufficient to show that there may still be a height which the water will not pass, and that this height depends on the proportion between the stroke of the piston and its distance from the water in the cistern. We need not give the determination, because it will come in afterwards in combination with other circumstances. It is enough that the reader sees the physical causes of this limitation: And, lastly, we see plainly that the utmost security will be given for the performance of the pump, when the fixed valve is so placed that the piston, when in its lowest position, shall come into contact with it. In this case, the rarefaction of the air will be the completest possible; and, if there were no space left between the piston and valve, and all were perfectly air-tight, the rarefaction would be complete, and the valve might be any thing less than 33 feet from the surface of the water in the cistern.

But this perfect contact and tightness is unattainable; and though the pump may be full of water, its continual downward pressure causes it to filtrate slowly through every crevice, and the air enters through every pore, and even disengages itself from the water, with which a considerable portion had been chemically combined. The pump by this means loses water, and it requires several strokes of brisk working to fill it again:

and

Pump.

II
Mode of insuring the delivery of water.

22
Valves not easily kept air-tight.

Pump.

and if the leathers have become dry, so much admission may be given to the air, that the pump will not fill itself with water by any working. It is then necessary to pour water into it, which shuts up these passages, and soon sets all to rights again. For these reasons, it is always prudent to place the fixed valve as low as other circumstances will permit, and to make the piston rod of such a length, that when it is at the bottom of its stroke it shall be almost in contact with the valve. When we are not limited by other circumstances, it is evident that the best possible form is to have both the piston and the fixed valve under the surface of the water of the cistern. In this situation they are always wet and air-tight. The chief objection is, that by this disposition they are not easily come at when needing repair. This is a material objection in deep mines. In such situations, therefore, we must make the best compensation of different circumstances that we can. It is usual to place the fixed valve at a moderate distance from the surface of the water, and to have a hole in the side of the pipe, by which it may be got out. This is carefully shut up by a plate firmly screwed on, with leather or cement between the parts. This is called the *clack door*. It would, in every case, be very proper to have a fixed valve in the lower end of the pipe. This would combine all advantages. Being always tight, the pipe would retain the water, and it would leave to the valve above it its full effect of increasing the rarefaction. A similar hole is made in the working barrel, a little above the highest position of the piston. When this needs repair, it can be got at through this hole, without the immense trouble of drawing up the whole rods.

Thus we have conducted the reader step by step, from the simplest form of the pump to that which long experience has at last selected as the most generally convenient. This we shall now describe in some detail.

13
Description of the sucking-pump.

The SUCKING PUMP consists of two pipes BAAB (fig. 5.); of which the former is called the *Barrel*, or the *Working Barrel*, and the other is called the *Suction-pipe*, and is commonly of a smaller diameter.—These are joined by means of stanches E, F, pierced with holes to receive screwed bolts. A ring of leather, or of lead, covered with a proper cement, is put between them; which, being strongly compressed by the screw-bolts, renders the joint perfectly air-tight.—The lower end A of the suction-pipe is commonly spread out a little to facilitate the entry of the water, and frequently has a grating across it at AA to keep out filth or gravel. This is immersed in the standing water YZ. The working barrel is cylindrical, as evenly and smoothly bored as possible, that the piston may fill it exactly through its whole length, and move along it with as little friction as may be consistent with air-tightness.

The piston is a sort of truncated cone OPKL, generally made of wood not apt to split, such as elm or beech. The small end of it is cut off at the sides, so as to form a sort of arch OQP, by which it is fastened to the iron rod or spear. It is exhibited in different positions in figures 6, 7. which will give a more distinct notion of it than any description. The two ends of the conical part may be hooped with brass. This cone has its larger end surrounded with a ring or band of strong leather fastened with nails, or by a copper hoop, which is driven on it at the smaller end. This band should reach to some distance beyond the base of

the cone; the farther the better: and the whole must be of uniform thickness all round, so as to suffer equal compression between the cone and the working barrel. The seam or joint of the two ends of this band must be made very close, but not sewed or stitched together. This would occasion bumps or inequalities, which would spoil its tightness; and no harm can result from the want of it, because the two edges will be squeezed close together by the compression in the barrel. It is by no means necessary that this compression be great. This is a very detrimental error of the pump-makers. It occasions enormous friction, and destroys the very purpose which they have in view, viz. rendering the piston air-tight; for it causes the leather to wear through very soon at the edge of the cone, and it also wears the working barrel. This very soon becomes wide in that part which is continually passed over by the piston, while the mouth remains of its original diameter, and it becomes impossible to thrust in a piston which shall completely fill the worn part. Now, a very moderate pressure is sufficient for rendering the pump perfectly tight, and a piece of glove leather would be sufficient for this purpose, if loose or detached from the solid cone; for suppose such a loose and flexible, but impervious, band of leather put round the piston, and put into the barrel; and let it even be supposed that the cone does not compress it in the smallest degree to its internal surface.—Pour a little water carefully into the inside of this sort of cup or dish; it will cause it to swell out a little, and apply itself close to the barrel all round, and even adjust itself to all its inequalities. Let us suppose it to touch the barrel in a ring of an inch broad all round. We can easily compute the force with which it is pressed. It is half the weight of a ring of water an inch deep and an inch broad. This is a trifle, and the friction occasioned by it not worth regarding; yet this trifling pressure is sufficient to make the passage perfectly impervious, even by the most enormous pressure of a high column of incumbent water: for let this pressure be ever so great, the pressure by which the leather adheres to the barrel always exceeds it, because the incumbent fluid has no *preponderating* power by which it can force its way between them, and it must insinuate itself precisely so far, that its pressure on the inside of the leather shall still exceed, and only exceed, the pressure by which it endeavours to insinuate itself; and thus the piston becomes perfectly tight with the smallest possible friction. This reasoning is perhaps too refined for the un instructed artist, and probably will not persuade him. To such we would recommend an examination of the pistons and valves contrived and executed by that artist, whose skill far surpasses our highest conceptions, the all-wise Creator of this world. The valves which shut up the passages of the veins, and this in places where an extravasation would be followed by instant death, are cups of thin membrane, which adhere to the sides of the channel about half way round, and are detached in the rest of their circumference. When the blood comes in the opposite direction, it pushes the membrane aside, and has a passage perfectly free. But a stagnation of motion allows the tone of the muscular (perhaps) membrane, to restore it to its natural shape, and the least motion in the opposite direction causes it instantly to clap close to the sides of the vein, and then no pressure whatever can force a passage. We shall recur

Pump.

14
Necessity of air tightness not properly attended to.

15
An easy mode of rendering pumps tight.

16
Provided to be practicable from the human frame.

Pump.
17
Best form
of a piston
recom-
mended.

to this again, when describing the various contrivances of valves, &c. What we have said is enough for supporting our directions for constructing a tight piston. But we recommended thick and strong leather, while our present reasoning seems to render thin leather preferable. If the leather be thin, and the solid piston in any part does not press it gently to the barrel, there will be in this part an unbalanced pressure of the incumbent column of water, which would instantly burst even a strong leather bag; but when the solid piston, covered with leather, exactly fills the barrel, and is even pressed a little to it, there is no such risk; and now that part of the leather band which reaches beyond the solid piston performs its office in the completest manner. We do not hesitate, therefore, to recommend this form of a piston, which is the most common and simple of all, as preferable, when well executed, to any of those more artificial, and frequently very ingenious, constructions, which we have met with in the works of the first engineers. To proceed, then, with our description of the sucking-pump.

18
Further description of
the sucking-
pump.

At the joining of the working barrel with the suction pipe there is a hole H, covered with a valve opening upwards. This hole H is either made in a plate which makes a part of the suction-pipe, being cast along with it, or it is made in a separate plate. This last is the most convenient, being easily removed and replaced. Different views are given of this valve in fig. 8, 9, 10. The diameter EF (fig. 10.) of this plate is the same with that of the flanches, and it has holes corresponding to them, through which their bolts pass which keep all together. A ring of thick leather NKL is applied to this plate, having a part cut out between N and L, to make room for another piece of strong leather NR (fig. 9.) which composes the valve. The circular part of this valve is broader than the hole in the middle of fig. 10. but not quite so broad as to fill up the inside of the ring of leather OQP of this fig. which is the same with GKI of fig. 10. The middle of this leather valve is strengthened by two brass (not iron) plates, the uppermost of which is seen at R of fig. 9: the one on its under side is a little smaller than the hole in the valve-plate, that it may go freely in; and the upper plate R is larger than this hole, that it may compress the leather to its brim all round. It is evident, that when this plate with its leathers is put between the joint flanches, and all is screwed together, the tail of leather N of fig. 9. will be compressed between the plates, and form a hinge, on which the valve can turn, rising and falling. There is a similar valve fastened to the upper side, or broadest base of the piston. This description serves for both valves, and in general for most valves which are to be found in any parts of a pump.

19
Its mode
of opera-
tion.

The reader will now understand, without any repetition, the process of the whole operation of a sucking-pump. The piston rarefies the air in the working barrel, and that in the suction-pipe expands thro' the valve into the barrel; and, being no longer a balance for the atmospheric pressure, the water rises into the suction-pipe; another stroke of the piston produces a similar effect, and the water rises farther, but by a smaller step than by the preceding stroke: by repeating the strokes of the piston, the water gets into the barrel; and when the piston is now pushed down through it, it gets above the piston, and must now be lifted up to any

height. The suction-pipe is commonly of smaller size than the working barrel, for the sake of economy. It is not necessary that it be so wide: but it may be, and often is, made too small. It should be of such a size, that the pressure of the atmosphere may be able to fill the barrel with water as fast as the piston rises. If a void is left below the piston, it is evident that the piston must be carrying the whole weight of the atmosphere, besides the water which is lying above it. Nay, if the pipe be only so wide, that the barrel shall fill precisely as fast as the piston rises, it must sustain all this pressure. The suction-pipe should be wider than this, that all the pressure of the atmosphere which exceeds the weight of the pillar in the suction-pipe may be employed in pressing it on the under surface of the piston, and thus diminish the load. It cannot be made too wide; and too strict an economy in this respect may very sensibly diminish the performance of the pump, and more than defeat its own purpose. This is most likely when the suction-pipe is long, because there the length of the pillar of water nearly balances the air's pressure, and leaves very little accelerating force; so that water will rise but slowly even in the widest pipe. All these things will be made the subjects of computation afterwards.

It is plain that there will be limitations to the rise of the water in the suction-pipe, similar to what we found when the whole pump was an uniform cylinder. Let a be the height of the fixed valve above the water in the cistern: let B and b be the spaces in cubic measure between this valve and the piston in its highest and lowest positions, and therefore express the bulks of the air which may occupy these spaces: let y be the distance between the fixed valve and the water in the suction-pipe, when it has attained its greatest height by the rarefaction of the air above it: let h be the height of a column of water in equilibrio, with the whole pressure of the atmosphere, and therefore having its weight in equilibrio with the elasticity of common air: and let x be the height of the column whose weight balances the elasticity of the air in the suction-pipe, when rarefied as much as it can be by the action of the piston, the water standing at the height $a-y$.

Then, because this elasticity, together with the column $a-y$ in the suction-pipe, must balance the whole pressure of the atmosphere, (see PNEUMATICS, n^o 108.), we must have $b = x + a - y$, and $y = a + x - b$.

When the piston was in its lowest position, the bulk of the air between it and the fixed valve was b . Suppose the valve kept shut, and the piston raised to its highest position, the bulk will be B , and its density $\frac{b}{B}$, and its elasticity, or the height of the column whose

weight will balance it, will be $b \frac{b}{B}$. If the air in the suction-pipe be denser than this, and consequently more elastic, it will lift the valve, and some will come in; therefore, when the pump has rarefied the air as much as it can, so that none does, in fact, come in, the elasticity of the air in the suction-pipe must be the same.

Therefore $x = b \frac{b}{B}$.

Pump.

We had $y = a + x - b$. Therefore $y = a + b \frac{B}{B} - b = a + \frac{B-B}{B} b = a - \frac{B-b}{B} b$.

Therefore when $\frac{B-b}{B} b$ is less than a , the water will stop before it reaches the fixed valve. But when a is less than $\frac{B-b}{B} b$, the water will get above the fixed valve, y becoming negative.

But it does not follow that the water will reach the piston, that is, will rise so high that the piston will pass through it in its descent. Things now come into the condition of a pump of uniform dimensions from top to bottom; and this point will be determined by what was said when treating of such a pump.

20
The same pump is used in an inverted position;

There is another form of the sucking pump which is much used in great water works, and is of equal efficacy with the one now described. It is indeed the same pump in an inverted position. It is represented in fig. 11. where ABCD is the working barrel, immersed, with its mouth downwards, in the water of the cistern. It is joined by means of flanches to the rising pipe or MAIN.

This usually consists of two parts. The first, BEFC, is bent to one side, that it may give room for the iron frames TXYV, which carries the rod NO of the piston M, attached to the traverses RS, TOV of this frame. The other part, EGHF, is usually of a less diameter, and is continued to the place of delivery. The piston frame XTVY hangs by the rod Z, at the arm of a lever or working beam, not brought into the figure. The piston is perforated like the former, and is surrounded like it with a band of leather in form of a taper-dish. It has a valve K on its broad or upper base, opening when pressed from below. The upper end of the working barrel is pierced with a hole, covered with a valve I, also opening upwards.

Now suppose this apparatus immersed into the cistern till the water is above it, as marked by the line 2, 3, and the piston drawn up till it touch the end of the barrel. When the piston is allowed to descend by its own weight, the water rises up through its valve K, and fills the barrel. If the piston be now drawn up by the moving power of the machinery with which it is connected, the valve K shuts, and the piston pushes the water before it through the valve I into the main-pipe EFGH. When the piston is again let down, the valve I shuts by its own weight and the pressure of the water incumbent on it, and the barrel is again filled by the water of the cistern. Drawing up the piston pushes this water into the main pipe, &c. and then the water is at length delivered at the place required.

21
And is called a *lifting pump*. This pump is usually called the *lifting pump*; perhaps the simplest of all in its principle and operation.— It needs no farther explanation: and we proceed to describe

22
Forcing-pump described.

The FORCING PUMP, represented in fig. 12. It consists of a working barrel ABCD, a suction-pipe CDEF, and a main or rising pipe. This last is usually in three joints. The first GHKI may be considered as making part of the working barrel, and is commonly cast in one piece with it. The second IKLM is joined to it by flanches, and forms the elbow which this

pipe must generally have. The third INOM is properly the beginning of the main, and is continued to the place of delivery. At the joint IK there is a hanging valve or clack S; and there is a valve R on the top of the suction-pipe.

The piston PQTV is solid, and is fastened to a stout iron rod which goes through it, and is fixed by a key drawn through its end. The body of the piston is a sort of double cone, widening from the middle to each end, and is covered with two bands of very strong leather, fitted to it in the manner already described.

23
The operation of this pump is abundantly simple. Its mode of operation. When the piston is thrust into the pump, it pushes the air before it through the valve S, for the valve R remains shut by its own weight. When it has reached near the bottom, and is drawn up again, the air which filled the small space between the piston and the valve S now expands into the barrel; for as soon as the air begins to expand, it ceases to balance the pressure of the atmosphere, which therefore shuts the valve S. By the expansion of the air in the barrel the equilibrium at the valve R is destroyed, and the air in the suction-pipe lifts the valve, and expands into the barrel; consequently it ceases to be a balance for the pressure of the atmosphere, and the water is forced into the suction-pipe.

Pushing the piston down again forces the air in the barrel through the valve S, the valve R in the mean time shutting. When the piston is again drawn up, S shuts, R opens, the air in the suction-pipe dilates anew, and the water rises higher in it. Repeating these operations, the water gets at last into the working barrel, and is forced into the main by pushing down the piston, and is pushed along to the place of delivery.

24
The operation of this pump is therefore two-fold, Is two-fold. sucking and forcing. In the first operation, the same force must be employed as in the sucking-pump, namely, a force equal to the weight of a column of water having the section of the piston for its base, and the height of the piston above the water in the cistern for its height. It is for the sake of this part of the operation that the upper cone is added to the piston. The air and water would pass by the sides of the lower cone while the piston is drawn up; but the leather of the upper cone applies to the surface of the barrel, and prevents this. The space contained between the barrel and the valve S is a great obstruction to this part of the operation, because this air cannot be rarefied to a very great degree. For this reason, the suction-pipe of a forcing-pump must not be made long. It is not indeed necessary; for by placing the pump a few feet lower, the water will rise into it without difficulty, and the labour of suction is as much diminished as that of impulsion is increased. However, an intelligent artist will always endeavour to make this space between the valve S and the lowest place of the piston as small as possible.

The power employed in forcing must evidently surmount the pressure of the whole water in the rising pipe, and (independent of what is necessary for giving the water the required velocity, so that the proper quantity per hour may be delivered), the piston has to withstand a force equal to the weight of a column of water having the section of the piston for its base, and the perpendicular altitude of the place of delivery above the lower surface of the piston for its height. It is quite

Pump. quite indifferent in this respect what is the diameter of the rising pipe; because the pressure on the piston depends on the altitude of the water only, independent of its quantity. We shall even see that a small rising pipe will require a greater force to convey the water along it to any given height or distance.

When we would employ a pump to raise water in a crooked pipe, or in any pipe of moderate dimensions, this form of pump, or something equivalent, must be used. In bringing up great quantities of water from mines, the common sucking-pump is generally employed, as really the best of them all: but it is the most expensive, because it requires the pipe to be perpendicular, straight, and of great dimensions, that it may contain the piston rods. But this is impracticable when the pipe is crooked.

If the forcing pump, constructed in the manner now described, be employed, we cannot use forcers with long rods. These would bend when pushed down by their further extremity. In this case, it is usual to employ only a short and stiff rod, and to hang it by a chain, and load it with a weight superior to the weight of water to be raised by it. The machinery therefore is employed, not in forcing the water along the rising-pipe, but in raising the weight which is to produce this effect by its subsequent descent.

In this case, it would be much better to employ the lifting-pump of fig. 11. For as the load on the forcers must be greater than the resistances which it must surmount, the force exerted by the machine must in like manner be greater than this load. This double excess would be avoided by using the lifting-pump.

25 Measure of the quantity of water delivered by any pump. It will readily occur to the reader that the quantity of water delivered by any pump will be in the joint proportion of the surface or base of the piston and its velocity: for this measures the capacity of that part of the working barrel which the piston passes over. The velocity of the water in the conduit pipe, and in its passage through every valve, will be greater or less than the velocity of the piston in the same proportion that the area of the piston or working barrel is greater or less than the area of the conduit or valve. For whatever quantity of water passes through any section of the working-barrel in a second, the same quantity must go through any one of these passages. This enables us to modify the velocity of the water as we please: we can increase it to any degree at the place of delivery by diminishing the aperture through which it passes, provided we apply sufficient force to the piston.

26 The operation of pumps not equable; It is evident that the operation of a pump is by starts, and that the water in the main remains at rest, pressing on the valve during the time that the piston is withdrawn from the bottom of the working barrel. It is in most cases desirable to have this motion equable, and in some cases it is absolutely necessary. Thus, in the engine for extinguishing fires, the spout of water going by jerks could never be directed with a certain aim, and half of the water would be lost by the way; because a body at rest cannot in an instant be put in rapid motion, and the first portion of every jerk of water would have but a small velocity. A very ingenious contrivance has been fallen upon for obviating this inconvenience, and procuring a stream nearly equable. We have not been able to discover the author. At any

27 And the mode of making them so.

convenient part of the rising pipe beyond the valve S there is annexed a capacious vessel VZ (fig. 13. n° 1 and 2.) close atop, and of great strength. When the water is forced along this pipe, part of it gets into this vessel, keeping the air confined above it, and it fills it to such a height V, that the elasticity of the confined air balances a column reaching to T, we shall suppose, in the rising pipe. The next stroke of the piston sends forward more water, which would fill the rising pipe to some height above T. But the pressure of this additional column causes some more of it to go into the air vessel, and compresses its air so much more that its elasticity now balances a longer column. Every succeeding stroke of the piston produces a like effect. The water rises higher in the main pipe, but some more of it goes into the air-vessel. At last the water appears at the place of delivery; and the air in the air-vessel is now so much compressed that its elasticity balances the pressure of the whole column. The next stroke of the piston sends forward some more water. If the diameter of the orifice of the main be sufficient to let the water flow out with a velocity equal to that of the piston, it will so flow out, rising no higher, and producing no sensible addition to the compression in the air-vessel. But if the orifice of the main be contracted to half its dimensions, the water sent forward by the piston cannot flow out in the time of the stroke without a greater velocity, and therefore a greater force. Part of it, therefore, goes into the air-vessel, and increases the compression. When the piston has ended its stroke, and no more water comes forward, the compression of the air in the air-vessel being greater than what was sufficient to balance the pressure of the water in the main pipe, now forces out some of the water which is lying below it. This cannot return towards the pump, because the valve S is now shut. It therefore goes forward along the main, and produces an efflux during the time of the piston's rising in order to make another stroke. In order that this efflux may be very equable, the air-vessel must be very large. If it be small, the quantity of water that is discharged by it during the return of the piston makes so great a portion of its capacity, that the elasticity of the confined air is too much diminished by this enlargement of its bulk, and the rate of efflux must diminish accordingly. The capacity of the air-vessel should be so great that the change of bulk of the compressed air during the inaction of the piston may be inconsiderable. It must therefore be very strong.

It is pretty indifferent in what way this air-vessel is connected with the rising pipe. It may join it laterally, as in fig. 13. n° 1. and the main pipe go on without interruption; or it may be made to surround an interruption of the main pipe, as in fig. 13. n° 2. It may also be in any part of the main-pipe. If the sole effect intended by it is to produce an equable jet, as in ornamental water-works, it may be near the end of the main. This will require much less strength, because there remains but a short column of water to compress the air in it. But it is, on the whole, more advantageous to place it as near the pump as possible, that it may produce an equable motion in the whole main-pipe. This is of considerable advantage; when a column of water several hundred feet long is at rest in the main-pipe, and the piston at one end of it put at once into motion,

even

Pump.

Pump.

28
The deful-
tory mo-
tion of
the pistons

even with a moderate velocity, the strain on the pipe would be very great. Indeed if it were possible to put the piston instantaneously into motion with a finite velocity, the strain on the pipe, tending to burst it, would be next to infinite. But this seems impossible in nature; all changes of motion *which we observe* are gradual, because all impelling bodies have some elasticity or softness by which they yield to compression. And, in the way in which pistons are commonly moved, viz. by cranks, or something analogous to them, the motion is *very sensibly* gradual. But still the air-vessel tends to make the motion along the main-pipe less defultory, and therefore diminishes those strains which would really take place in the main-pipe. It acts like the springs of a travelling carriage, whose jolts are incomparably less than those of a cart; and by this means really enables a given force to propel a greater quantity of water in the same time.

29
Corrected.

We may here by the way observe, that the attempts of mechanicians to correct this unequal motion of the piston-rod are misplaced, and if it could be done, would greatly hurt a pump. One of the best methods of producing this effect is to make the piston-rod consist of two parallel bars, having teeth in the sides which front each other. Let a toothed wheel be placed between them, having only the half of its circumference furnished with teeth. It is evident, without any farther description, that if this wheel be turned uniformly round its axis, the piston-rod will be moved uniformly up and down without intermission. This has often been put in practice; but the machine always went by jolts, and seldom lasted a few days. Unskilled mechanicians attributed this to defect in the execution: but the fault is essential, and lies in the principle.

30
But on a
wrong prin-
ciple.

The machine could not perform one stroke, if the first mover did not slacken a little, or the different parts of the machine did not yield by bending or by compression; and no strength of materials could withstand the violence of the strains at every reciprocation of the motion. This is chiefly experienced in great works which are put in motion by a water-wheel, or some other equal power exerted on the mass of matter of which the machine consists. The water-wheel being of great weight, moves with considerable steadiness or uniformity; and when an additional resistance is opposed to it by the beginning of a new stroke of the piston, its great quantity of motion is but little affected by this addition, and it proceeds very little retarded; and the machine must either yield a little by bending and compression, or go to pieces, which is the common event. Cranks are free from this inconvenience, because they accelerate the piston gradually, and bring it gradually to rest, while the water-wheel moves round with almost perfect uniformity. The only inconvenience (and it may be considerable) attending this slow motion of the piston at the beginning of its stroke is, that the valves do not shut with rapidity, so that some water gets back through them. But when they are properly formed and loaded, this is but trifling.

31
These equa-
ble pumps
deliver very
little more
water than
the others.

We must not imagine, that because the stream produced by the assistance of an air-barrel is almost perfectly equable, and because as much water runs out during the returning of the piston as during its active stroke, it therefore doubles the quantity of water. No more water can run out than what is sent forward by

the piston during its effective stroke. The continued stream is produced only by preventing the whole of this water from being discharged during this time, and by providing a propelling force to act during the piston's return. Nor does it enable the moving force of the piston to produce a double effect: for the compression which is produced in the air-vessel, more than what is necessary for merely balancing the quiescent column of water, reacts on the piston, resisting its compression just as much as the column of water would do which produces a velocity equal to that of the efflux. Thus if the water is made to spout with the velocity of eight feet per second, this would require an additional column of one foot high, and this would just balance the compression in the air-vessel, which maintains this velocity during the non-action of the piston. It is, however, a matter of fact, that a pump furnished with an air-vessel delivers a little more water than it would do without it. But the difference depends on the combination of many very dissimilar circumstances, which it is extremely difficult to bring into calculation. Some of these will be mentioned afterwards.

To describe, or even to enumerate, the immense variety of combinations of these three simple pumps would fill a volume. We shall select a few, which are more deserving of notice.

I. The common sucking-pump may, by a small ad-
dition, be converted into a lifting-pump, fitted for pro-
pelling the water to any distance, and with any velo-
city.

32
The suck-
ing pump
converted
into a lift-
ing pump.

Fig. 14. is a sucking-pump, whose working-barrel ACDB has a lateral pipe AEGHF connected with it close to the top. This terminates in a *main* or rising pipe IK, furnished or not with a valve L. The top of the barrel is shut up by a strong plate MN, having a hollow neck terminating in a small flanch. The piston rod QR passes through this neck, and is nicely turned and polished. A number of rings of leather are put over the rod, and strongly compressed round it by another flanch and several screwed bolts, as is represented at OP. By this contrivance the rod is closely grasped by the leathers, but may be easily drawn up and down, while all passage of air or water is effectually prevented.

The piston S is perforated, and furnished with a valve opening upwards. There is also a valve T on the top of the suction-pipe YX; and it will be of advantage, though not absolutely necessary, to put a valve L at the bottom of the rising pipe. Now suppose the piston at the bottom of the working-barrel. When it is drawn up, it tends to compress the air above it, because the valve in the piston remains shut by its own weight. The air therefore is driven through the valve L into the rising pipe, and escapes. In the mean time, the air which occupied the small space between the piston and the valve T expands into the upper part of the working barrel; and its elasticity is so much diminished thereby, that the atmosphere presses the water of the cistern into the suction-pipe, where it will rise till an equilibrium is again produced. The next downward stroke of the piston allows the air, which had come from the suction-pipe into the barrel during the ascent of the piston, to get through its valve. Upon drawing up the piston, this air is also drawn off through the rising pipe. Repeating this process brings the wa-

Pump. ter at last into the working-barrel, and it is then driven along the rising-pipe by the piston.

³³ **Advantages of this construction.** This is one of the best forms of a pump. The refraction may be very perfect, because the piston can be brought so near to the bottom of the working-barrel: and, for forcing water in opposition to great pressures, it appears preferable to the common forcing-pump; because in that the piston rods are compressed and exposed to bending, which greatly hurts the pump by wearing the piston and barrel on one side. This soon renders it less tight, and much water squirts out by the sides of the piston. But in this pump the piston rod is always drawn or pulled, which keeps it straight; and rods exert a much greater force in opposition to a pull than in opposition to compression. The collar of leather round the piston-rods is found by experience to need very little repairs, and is very impervious to water. The whole is very accessible for repairs; and in this respect much preferable to the common pump in deep mines, where every fault of the piston obliges us to draw up some hundred feet of piston-rods. By this addition, too, any common pump for the service of a house is converted into an engine for extinguishing fire, or may be made to convey the water to every part of the house; and this without hurting or obstructing its common uses. All that is necessary is to have a large cock on the upper part of the working barrel opposite to the lateral pipe in this figure. This cock serves for a spout when the pump is used for common purposes; and the merely shutting this cock converts the whole into an engine for extinguishing fire or for supplying distant places with water. It is scarcely necessary to add, that for these services it will be proper to connect an air-vessel with some convenient part of the rising pipe, in order that the current of the water may be continual.

³⁴ **Equable streams produced in great works by combinations.**

We have frequently spoken of the advantages of a continued current in the main pipe. In all great works a considerable degree of uniformity is produced by the manner of disposing the actions of the different pumps; for it is very rarely that a machine works but one pump. In order to maintain some uniformity in the resistance, that it may not all be opposed at once to the moving power, with intervals of total inaction, which would produce a very hobbling motion, it is usual to distribute the work into portions, which succeed alternately; and thus both diminish the strain, and give greater uniformity of action, and frequently enable a natural power which we can command, to perform a piece of work, which would be impossible if the whole resistance were opposed at once. In all pump machines therefore we are obviously directed to construct them so that they may give motion to at least two pumps, which work alternately. By this means a much greater uniformity of current is produced in the main pipe. It will be rendered still more uniform if four are employed, succeeding each other at the interval of one quarter of the time of a complete stroke.

³⁵ **A single pump for this purpose described.**

But ingenious men have attempted the same thing with a single pump, and many different constructions for this purpose have been proposed and executed. The thing is not of much importance, nor of great research. We shall content ourselves therefore with the description of one that appears to us the most perfect, both in respect of simplicity and effect.

Pump. II. It consists of a working-barrel AB (fig. 15.) close at both ends. The piston C is solid, and the rod OP passes through a collar of leathers in the plate, which closes the upper end of the working-barrel. This barrel communicates laterally with two pipes H, K; the communications *m* and *n* being as near to the top and bottom of the barrel as possible. Adjoining to the passage *m* are two valves F and G opening upwards. Similar valves accompany the passage *n*. The two pipes H and K unite in a larger rising pipe L. They are all represented as in the same plane; but the upper ends must be bent backwards, to give room for the motion of the piston-rod OP.

Suppose the piston close to the entry of the lateral pipe *n*, and that it is drawn up: it compresses the air above it, and drives it through the valve G, where it escapes along the rising pipe; at the same time it rarefies the air in the space below it. Therefore the weight of the atmosphere shuts the valve E, and causes the water of the cistern to rise through the valve D, and fill the lower part of the pump. When the piston is pushed down again, this water is first driven through the valve E, because D immediately shuts; and then most of the air which was in this part of the pump at the beginning goes up through it, some of the water coming back in its stead. In the mean time, the air which remained in the upper part of the pump after the ascent of the piston is rarefied by its descent; because the valve G shuts as soon as the piston begins to descend, the valve F opens, the air in this suction pipe Ff expands into the barrel, and the water rises into the pipes by the pressure of the atmosphere. The next rise of the piston must bring more water into the lower part of the barrel, and must drive a little more air through the valve G, namely, part of that which had come out of the suction-pipe Ff; and the next descent of the piston must drive more water into the rising pipe H, and along with it most if not all of the air which remained below the piston, and must rarefy still more the air remaining above the piston; and more water will come in through the pipe Ff, and get into the barrel. It is evident that a few repetitions will at last fill the barrel on both sides of the piston with water. When this is accomplished, there is no difficulty in perceiving how, at every rise of the piston, the water of the cistern will come in by the valve D, and the water in the upper part of the barrel will be driven thro' the valve G; and, in every descent of the piston, the water of the cistern will come into the barrel by the valve F, and the water below the piston will be driven through the valve E: and thus there will be a continual influx into the barrel through the valves D and F, and a continual discharge along the rising pipe L through the valves E and G.

³⁶ This machine is, to be sure, equivalent to two forcing pumps, although it has but one barrel and one piston; but it has no sort of superiority. It is not even more economical in most cases; because we apprehend that the additional workmanship will fully compensate for the barrel and piston that is saved. There is indeed a saving in the rest of the machinery, because one lever produces both motions. We cannot therefore say that it is inferior to two pumps; and we acknowledge that there is some ingenuity in the contrivance.

We recommend to our readers the perusal of Belidor's

³⁷
Pump. ^{Authors re-} ^{commend-}
dor's *Architectare Hydraulique*, where is to be found a great variety of combinations and forms of the simple pumps; but we must caution them with respect to his theories, which in this article are extremely defective. Also in *Leupold's Theatrum Machinarum Hydraulicarum*, there is a prodigious variety of all kinds of pumps, many of them very singular and ingenious, and many which have particular advantages, which may suit local circumstances, and give them a preference. But it would be improper to swell a work of this kind with so many peculiarities; and a person who makes himself master of the principles delivered here in sufficient detail, can be at no loss to suit a pump to his particular views, or to judge of the merit of such as may be proposed to him.

We must now take notice of some very considerable and important varieties in the form and contrivance of the essential parts of a pump.

³⁸
The forcing
pump diff-
rently con-
structed.
Plate
ccccxxv.
III. The forcing pump is sometimes of a very different form from that already described. Instead of a piston, which applies itself to the inside of the barrel, and slides up and down in it, there is a long cylinder POQ (fig. 16.) nicely turned and polished on the outside, and of a diameter somewhat less than the inside of the barrel. This cylinder (called a PLUNGER) slides through a collar of leathers on the top of the working-barrel, and is constructed as follows. The top of the barrel terminates in a flanch *ab*, pierced with four holes for receiving screw-bolts. There are two rings of metal, *cd*, *ef*, of the same diameter, and having holes corresponding to those in the flanch. Four rings of soft leather, of the same size, and similarly pierced with holes, are well soaked in a mixture of oil, tallow, and a little rosin. Two of these leather rings are laid on the pump flanch, and one of the metal rings above them. The plunger is then thrust down through them, by which it turns their inner edges downwards. The other two rings are then slipped on at the top of the plunger, and the second metal ring is put over them, and then the whole are slid down to the metal ring. By this the inner edges of the last leather rings are turned upwards. The three metal rings are now forced together by the screwed bolts; and thus the leathern rings are strongly compressed between them, and made to grasp the plunger so closely that no pressure can force the water through between. The upper metal ring just allows the plunger to pass through it, but without any play; so that the turned up edges of the leathern rings do not come up between the plunger and the upper metal ring, but are lodged in a little conical taper, which is given to the inner edge of the upper plate, its hole being wider below than above. It is on this trifling circumstance that the great tightness of the collar depends. To prevent the leathers from shrinking by drought, there is usually a little cistern formed round the head of the pump, and kept full of water. The plunger is either forced down by a rod from a working beam, or by a set of metal-weights laid on it, as is represented in the figure.

³⁹
Its mode of
operation.
It is hardly necessary to be particular in explaining the operation of this pump. When the plunger is at the bottom of the barrel, touching the fixed valve M with its lower extremity, it almost completely fills it. That it may do it completely, there is sometimes a small pipe RSZ branching out from the top of the barrel,

and fitted with a cock at S. Water is admitted till the barrel is completely filled, and the cock is then shut. Now when the plunger is drawn up, the valve N in the rising pipe must remain shut by the pressure of the atmosphere, and a void must be made in the barrel. Therefore the valve M on the top of the suction-pipe must be opened by the elasticity of the air in this pipe, and the air must expand into the barrel; and, being no longer a balance for the atmosphere, the water in the cistern must be forced into the suction-pipe, and rise in it to a certain height. When the plunger descends, it must drive the water through the valve N (for the valve M will immediately shut), and along with it most of the air which had come into the barrel. And as this air occupied the upper part of the barrel, part of it will remain when the plunger has reached the bottom; but a stroke or two will expel it all, and then every succeeding stroke of the descending piston will drive the water along the rising pipe, and every ascent of the plunger will be followed by the water from the cistern.

The advantage proposed by this form of piston is, that it may be more accurately made and polished than the inside of a working barrel, and it is of much easier repair. Yet we do not find that it is much used, although an invention of last century (we think by Sir Samuel Morland), and much praised by the writers on these subjects.

⁴⁰
It is easy to see that the sucking-pump may be varied in the same way. Suppose this plunger to be open both at top and bottom, but the bottom filled with a valve opening upward. When this is pushed to the bottom of the barrel, the air which it tends to compress lifts the valve (the lateral pipe FIK being taken away and the passage shut up), and escapes through the plunger. When it is drawn up, it makes the same rarefaction as the solid plunger, because the valve at O shuts, and the water will come up from the cistern as in the former case. If the plunger be now thrust down again, the valve M shuts, the valve O is forced open, and the plunger is filled with water. This will be lifted by it during its next ascent; and when it is pushed down again, the water which filled it must now be pushed out, and will flow over its sides into the cistern at the head of the barrel. Instead of making the valve at the bottom of the piston, it may be made at the top; but this disposition is much inferior, because it cannot rarefy the air in the barrel one half. This is evident; for the capacity of the barrel and plunger together cannot be twice the capacity of the barrel.

⁴¹
IV. It may be made after a still different form, as represented in fig. 17. Here the suction-pipe CO comes up through a cistern KMNL deeper or longer than the intended stroke of the piston, and has a valve C at top. The piston, or what acts in lieu of it, is a tube AHGB, open at both ends, and of a diameter somewhat larger than that of the suction-pipe. The interval between them is filled up at HG by a ring or belt of soft leather, which is fastened to the outer tube, and moves up and down with it, sliding along the smoothly polished surface of the suction-pipe with very little friction. There is a valve I on the top of this piston, opening upwards. Water is poured into the outer cistern.

⁴²
The outer cylinder or piston being drawn up from the bottom, there is a great rarefaction of the air which

Pump.

Sucking-pump similarly varied.

⁴¹ Another form of the sucking-pump.⁴² And its mode of operation was

Pump.

was between them, and the atmosphere presses the water up through the suction-pipe to a certain height; for the valve I keeps shut by the pressure of the atmosphere and its own weight. Pushing down the piston causes the air, which had expanded from the suction-pipe into the piston, to escape through the valve I; drawing it up a second time, allows the atmosphere to press more water into the suction-pipe, to fill it, and also part of the piston. When this is pushed down again, the water which had come through the valve C is now forced out through the valve I into the cistern KMNL, and now the whole is full of water. When, therefore, the piston is drawn up, the water follows, and fills it, if not 33 feet above the water in the cistern; and when it is pushed down again, the water which filled the piston is all thrown out into the cistern; and after this it delivers its full contents of water every stroke. The water in the cistern KMNL effectually prevents the entry of any air between the two pipes; so that a very moderate compression of the belt of soft leather at the mouth of the piston cylinder is sufficient to make all perfectly tight.

43
The piston
cylinder
differently
formed.

It might be made differently. The ring of leather might be fastened round the top of the inner cylinder at DE, and slide on the inside of the piston cylinder; but the first form is most easily executed. Muschenbroeck has given a figure of this pump in his large system of natural philosophy, and speaks very highly of its performance. But we do not see any advantage which it possesses over the common sucking-pump. He indeed says that it is without friction, and makes no mention of the ring of leather between the two cylinders. Such a pump will raise water extremely well to a small height, and it seems to have been a model only which he had examined: But if the suction-pipe is long, it will by no means do without the leather; for on drawing up the piston, the water of the upper cistern will rise between the pipes, and fill the piston, and none will come up through the suction-pipe.

44
Pumps
without
friction
not of im-
portant
use.

We may take this opportunity of observing, that the many ingenious contrivances of pumps without friction are of little importance in great works; because the friction which is completely sufficient to prevent all escape of water in a well-constructed pump is but a very trifling part of the whole force. In the great pumps which are used in mines, and are worked by a steam-engine, it is very usual to make the pistons and valves without any leather whatever. The working barrel is bored truly cylindrical, and the piston is made of metal of a size that will just pass along it without sticking. When this is drawn up with the velocity competent to a properly loaded machine, the quantity of water which escapes round the piston is insignificant. The piston is made without leathers, not to avoid friction, which is also insignificant in such works; but to avoid the necessity of frequently drawing it up for repairs through such a length of pipes.

45
Example
of a simple
pump with-
out fric-
tion.

V. If a pump absolutely without friction is wanted, the following seems preferable for simplicity and performance to any we have seen, when made use of in proper situations. Let NO (fig. 18.) be the surface of the water in the pit, and K the place of delivery. ABCD is a wooden trunk, round or square, open at both ends, and having a valve P at the bottom. The

top of this trunk must be on a level with K, and has a small cistern EADF. It also communicates laterally with a rising pipe GHK, furnished with a valve at H opening upwards. LM is a beam of timber so fitted to the trunk as to fill it without sticking, and is of at least equal length. It hangs by a chain from a working beam, and is loaded on the top with weights exceeding that of the column of water which it displaces. Now suppose this beam allowed to descend from the position in which it is drawn in the figure; the water must rise all around it, in the crevice which is between it and the trunk, and also in the rising pipe; because the valve P shuts, and H opens; so that when the plunger has got to the bottom, the water will stand at the level of K. When the plunger is again drawn up to the top by the action of the moving power, the water sinks again in the trunk, but not in the rising pipe, because it is stopped by the valve H. Then allowing the plunger to descend again, the water must again rise in the trunk to the level of K, and it must now flow out at K; and the quantity discharged will be equal to the part of the beam below the surface of the pit-water, deducting the quantity which fills the small space between the beam and the trunk. This quantity may be reduced almost to nothing; for if the inside of the trunk and the outside of the beam be made tapering, the beam may be let down till they exactly fit; and as this may be done in square work, a good workman can make it exceedingly accurate. But in this case, the lower half of the beam and trunk must not taper; and this part of the trunk must be of sufficient width round the beam to allow free passage into the rising pipe. Or, which is better, the rising pipe must branch off from the bottom of the trunk. A discharge may be made from the cistern EADF, so that as little water as possible may descend along the trunk when the piston is raised.

One great excellence of this pump is, that it is perfectly free from all the deficiencies which in common-⁴⁶ Its excel-
pumps result from want of being air-tight. Another^{consider-}
is, that the quantity of water raised is precisely equal^{able,}
to the power expended; for any want of accuracy in the work, while it occasions a diminution of the quantity of water discharged, makes an equal diminution in the weight which is necessary for pushing down the plunger. We have seen a machine consisting of two such pumps suspended from the arms of a long beam, the upper side of which was formed into a walk with a rail on each side. A man stood on one end till it got to the bottom, and then walked soberly up to the other end, the inclination being about twenty-five degrees at first, but gradually diminished as he went along, and changed the load of the beam. By this means he made the other end go to the bottom, and so on alternately, with the easiest of all exertions, and what we are most fitted for by our structure. With this machine, a very feeble old man, weighing 110 pounds, raised 7 cubic feet of water 11½ feet high in a minute, and continued working 8 or 10 hours every day. A stout young man, weighing nearly 135 pounds, raised 8½ to the same height; and when he carried 30 pounds, conveniently slung about him, he raised 9½ feet to this height, working 10 hours a-day without fatiguing himself. This exceeds Desaguliers's maximum of a hoghead of water 10 feet high in a minute, in the pro-
8 portion

Pump.

Pump.
47
But it is li-
quid.

48
Haskin's
pump de-
scribed.

Pump.

portion of 9 to 7 nearly. It is limited to very moderate heights; but in such situations it is very effectual. It was the contrivance of an untaught labouring man, possessed of uncommon mechanical genius. We shall have occasion to mention, with respect, some other contrivances of the same person in the article *WATER-Works*.

VI. The most ingenious contrivance of a pump without friction is that of Mr Haskins, described by Desaguliers, and called by him the *QUICKSILVER PUMP*. Its construction and mode of operation are pretty complicated; but the following preliminary observations will, we hope, render it abundantly plain.

Let *ilmk* (fig. 19.) be a cylindrical iron pipe, about six feet long, open at top. Let *egbf* be another cylinder, connected with it at the bottom, and of smaller diameter. It may either be solid, or, if hollow, it must be close at top. Let *acdb* be a third iron cylinder, of an intermediate diameter, so that it may move up and down between the other two without touching either, but with as little interval as possible. Let this middle cylinder communicate by means of the pipe *AB*, with the upright pipe *FE*, having valves *C* and *D* (both opening upwards) adjoining to the pipe of communication. Suppose the outer cylinder suspended by chains from the end of a working beam, and let mercury be poured into the interval between the three cylinders till it fills the space to *op*, about $\frac{1}{3}$ of their height. Also suppose that the lower end of the pipe *FE* is immersed into a cistern of water, and that the valve *D* is less than 33 feet above the surface of this water.

Now suppose a perforation made somewhere in the pipe *AB*, and a communication made with an air-pump. When the air-pump is worked, the air contained in *CE*, in *AB*, and in the space between the inner and middle cylinders, is rarefied, and is abstracted by the air-pump; for the valve *D* immediately shuts. The pressure of the atmosphere will cause the water to rise in the pipe *CE*, and will cause the mercury to rise between the inner and middle cylinders, and sink between the outer and middle cylinders. Let us suppose mercury 12 times heavier than water: Then for every foot that the water rises in *EC*, the level between the outside and inside mercury will vary an inch; and if we suppose *DE* to be 30 feet, then if we can rarefy the air so as to raise the water to *D*, the outside mercury will be depressed to *q, r*, and the inside mercury will have risen to *s, t, sq* and *tr* being about 30 inches. In this state of things, the water will run over by the pipe *BA*, and every thing will remain nearly in this position. The columns of water and mercury balance each other, and balance the pressure of the atmosphere.

While things are in this state of equilibrium, if we allow the cylinders to descend a little, the water will rise in the pipe *FE*, which we may now consider as a suction-pipe; for by this motion the capacity of the whole is enlarged, and therefore the pressure of the atmosphere will still keep it full, and the situation of the mercury will again be such that all shall be in equilibrio. It will be a little lower in the inside space and higher in the outside.

Taking this view of things, we see clearly how the water is supported by the atmosphere at a very consi-

derable height. The apparatus is analogous to a syphon which has one leg filled with water and the other with mercury. But it was not necessary to employ an air-pump to fill it. Suppose it again empty, and all the valves shut by their own weight. Let the cylinders descend a little. The capacity of the spaces below the valve *D* is enlarged, and therefore the included air is rarefied, and some of the air in the pipe *CE* must diffuse itself into the space quitted by the inner cylinder. Therefore the atmosphere will press some water up the pipe *FE*, and some mercury into the inner space between the cylinders. When the cylinders are raised again, the air which came from the pipe *CE* would return into it again, but is prevented by the valve *C*.—Raising the cylinders to their former height would compress this air; it therefore lifts the valve *D*, and escapes. Another depression of the cylinders will have a similar effect. The water will rise higher in *FC*, and the mercury in the inner space; and then, after repeated strokes, the water will pass the valve *C*, and fill the whole apparatus, as the air-pump had caused it to do before.—The position of the cylinders, when things are in this situation, is represented in fig. 20, the outer and inner cylinders in their lowest position having descended about 30 inches. The mercury in the outer space stands at *q, r*, a little above the middle of the cylinders, and the mercury in the inner space is near the top *ts* of the inner cylinder. Now let the cylinders be drawn up. The water above the mercury cannot get back again through the valve *C*, which shuts by its own weight. We therefore attempt to compress it; but the mercury yields, and descends in the inner space, and rises in the outer till both are quickly on a level, about the height *uv*.—If we continue to raise the cylinders, the compression forces out more mercury, and it now stands lower in the inner than in the outer space. But that there may be something to balance this inequality of the mercurial columns, the water goes through the valve *D*, and the equilibrium is restored when the height of the water in the pipe *ED* above the surface of the internal mercury is 12 times the difference of the mercurial columns (on the former supposition of specific gravity.) If the quantity of water is such as to rise two feet in the pipe *ED*, the mercury in the outer space will be two inches higher than that in the inner space. Another depression of the cylinders will again enlarge the space within the apparatus, the mercury will take the position of fig. 19. and more water will come in. Raising the cylinders will send this water four feet up the pipe *ED*, and the mercury will be four inches higher in the inner than in the outer space. Repeating this operation, the water will be raised still higher in *DE*; and this will go on till the mercury in the outer space reaches the top of the cylinder; and this is the limit of the performance. The dimensions with which we set out will enable the machine to raise the water about 30 feet in the pipe *ED*; which, added to the 30 feet of *CF*, makes the whole height above the pit-water 60 feet. By making the cylinders longer, we increase the height of *FD*. This machine must be worked with great attention, and but slowly; for at the beginning of the forcing stroke the mercury very rapidly sinks in the inner space and rises in the outer, and will dash out and be lost. To pre-

49
Its mode
of opera-
tion.

Pump.

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Ingenuity
of the con-
trivance
great,

51
But the ad-
vantage
trifling.

52
Description
of another
pump with-
out fric-
tion.

53
Its mode
of opera-
tion, &c.

vent this as much as possible, the outer cylinder terminates in a sort of cup or dish, and the inner cylinder should be tapered at top.

The machine is exceedingly ingenious and refined; and there is no doubt but that its performance will exceed that of any other pump which raises the water to the same height, because friction is completely avoided, and there can be no want of tightness of the piston.— But this is all its advantage; and, from what has been observed, it is but trifling. The expence would be enormous; for with whatever care the cylinders are made, the interval between the inner and outer cylinders must contain a very great quantity of mercury. The middle cylinder must be made of iron plate, and must be without a seam, for the mercury would dissolve every solder. For such reasons, it has never come into general use. But it would have been unpardonable to have omitted the description of an invention which is so original and ingenious; and there are some occasions where it may be of great use, as in nice experiments for illustrating the theory of hydraulics, it would give the finest pistons for measuring the pressures of water in pipes, &c. It is on precisely the same principle that the cylinder belows, described in the article PNEUMATICS, are constructed.

We beg leave to conclude this part of the subject with the description of a pump without friction, which may be constructed in a variety of ways by any common carpenter, without the assistance of the pump-maker or plumber, and will be very effective for raising a great quantity of water to small heights, as in draining marshes, marle pits, quarries, &c. or even for the service of a house.

VII. ABCD (fig. 21.) is a square trunk of carpenter's work open at both ends, and having a little cylinder and spout at top. Near the bottom there is a partition made of board, perforated with a hole E, and covered with a clack. *ffff* represents a long cylindrical bag or pudding, made of leather or of double canvas, with a fold of thin leather such as sheepskin between the canvas bags. This is firmly nailed to the board E with soft leather between. The upper end of this bag is fixed on a round board, having a hole and valve F. This board may be turned in the lathe with a groove round its edge, and the bag fastened to it by a cord bound tight round it. The fork of the piston-rod FG is firmly fixed into this board; the bag is kept distended by a number of wooden hoops or rings of strong wire *ff*, *ff*, *ff*, &c. put into it at a few inches distance from each other. It will be proper to connect these hoops before putting them in, by three or four cords from top to bottom, which will keep them at their proper distances. Thus will the bag have the form of a barber's bellows powder-puff. The distance between the hoops should be about twice the breadth of the rim of the wooden ring to which the upper valve and piston-rod are fixed.

Now let this trunk be immersed in the water. It is evident that if the bag be stretched from the compressed form which its own weight will give it by drawing up the piston-rod, its capacity will be enlarged, the valve F will be shut by its own weight, the air in the bag will be rarefied, and the atmosphere will press the water into the bag. When the rod is thrust down again, this water will come out by the valve F, and

fill part of the trunk. A repetition of the operation will have a similar effect; the trunk will be filled, and the water will at last be discharged by the spout.

Here is a pump without friction, and perfectly tight. For the leather between the folds of canvas renders the bag impervious both to air and water. And the canvas has very considerable strength. We know from experience that a bag of six inches diameter, made of sail-cloth no 3. with a sheep skin between, will bear a column of 15 feet of water, and stand six hours work per day for a month without failure, and that the pump is considerably superior in effect to a common pump of the same dimensions. We must only observe, that the length of the bag must be three times the intended length of the stroke; so that when the piston-rod is in its highest position, the angles or ridges of the bag may be pretty acute. If the bag be more stretched than this, the force which must be exerted by the labourer becomes much greater than the weight of the column of water which he is raising. If the pump be laid aslope, which is very usual in these occasional and hasty drawings, it is necessary to make a guide for the piston-rod within the trunk, that the bag may play up and down without rubbing on the sides, which would quickly wear it out.

The experienced reader will see that this pump is very like that of Goffet and De la Deuille, described by Belidor Vol. II. p. 120. and most writers on hydraulics. It would be still more like it, if the bag were on the under side of the partition E, and a valve placed farther down the trunk. But we think that our form is greatly preferable in point of strength. When in the other situation, the column of water lifted by the piston tends to *burst* the bag, and this with a great force, as the intelligent reader well knows. But in the form recommended here, the bag is *compressed*, and the strain on each part may be made much less than that which tends to burst a bag of six inches diameter. The nearer the rings are placed to each other the finaller will the strain be.

The same bag-piston may be employed for a forcing pump, by placing it below the partition, and inverting the valve; and it will then be equally strong, because the resistance in this case too will act by compression.

We now come naturally to the consideration of the different forms which may be given to the pistons and valves of a pump. A good deal of what we have been describing already is reducible to this head; but, having a more general appearance, changing as it were the whole form and structure of the pump, it was not improper to keep these things together.

The great desideratum in a piston is, that it be as tight as possible, and have as little friction as is consistent with this indispensable quality. We have already said, that the common form, when carefully executed, has these properties in an eminent degree. And accordingly this form has kept its ground amidst all the improvements which ingenious artists have made. Mr Belidor, an author of the first reputation, has given the description of a piston which he highly extols, and is undoubtedly a very good one, constructed from principle, and extremely well composed.

It consists of a hollow cylinder of metal *gh* (fig. 22.) An improved one by Belidor. pierced with a number of holes, and having at top a flanch AB, whose diameter is nearly equal to that of the

Pump.

54
pistons
should have
a little fric-
tion.

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^{Pump.} the working-barrel of the pump. This flanch has a groove round it. There is another flanch IK below, by which this hollow cylinder is fastened with bolts to the lower end of the piston, represented in fig. 23. This consists of a plate CD, with a grooved edge similar to AB, and an intermediate plate which forms the seat of the valve. The composition of this part is better understood by inspecting the figure than by any description. The piston-rod HL is fixed to the upper plate by bolts through its different branches at G, G. This metal body is then covered with a cylindrical bag of leather, fastened on it by cords bound round it, filling up the grooves in the upper and lower plates. The operation of the piston is as follows.

A little water is poured into the pump, which gets past the sides of the piston, and lodges below in the fixed valve. The piston being pushed down dips into this water, and it gets into it by the valve. But as the piston in descending compresses the air below it, this compressed air also gets into the inside of the piston, swells out the bag which surrounds it, and compresses it to the sides of the working-barrel. When the piston is drawn up again, it must remain tight, because the valve will shut and keep in the air in its most compressed state; therefore the piston must perform well during the suction. It must act equally well when pushed down again, and acting as a forcer; for however great the resistance may be, it will affect the air within the piston to the same degree, and keep the leather close applied to the barrel. There can be no doubt therefore of the piston's performing both its offices completely; but we imagine that the adhesion to the barrel will be greater than is necessary: it will extend over the whole surface of the piston, and be equally great in every part of its surface; and we suspect that the friction will therefore be very great. We have very high authority for supposing that the adhesion of a piston of the common form, carefully made, will be such as will make it perfectly tight; and it is evident that the adhesion of Belidor's piston will be much greater, and it will be productive of worse consequences. If the leather bag is worn through in any one place, the air escapes, and the piston ceases to be compressed altogether; whereas in the common piston there will very little harm result from the leather being worn through in one place, especially if it project a good way beyond the base of the cone. We still think the common piston preferable. Belidor's piston would do much better inverted as the piston of a sucking pump; and in this situation it would be equal, but not superior, to the common.

⁵⁶ Its defects. ⁵⁷ Another by the same author. ⁵⁸ Objections to it. Belidor describes another forcing piston, which he had executed with success, and prefers to the common wooden forcer. It consists of a metal cylinder or cone, having a broad flanch united to it at one end, and a similar flanch which is screwed on the other end. Between these two plates are a number of rings of leather strongly compressed by the two flanches, and then turned in a lathe like a block of wood, till the whole fits tight, when dry, into the barrel. It will swell, says he, and soften with the water, and withstand the greatest pressures. We cannot help thinking this but an indifferent piston. When it wears, there is nothing to squeeze it to the barrel. It may indeed be taken out and another ring or two of leather put in, or the flanches may be more strongly screwed together: but all this

may be done with any kind of piston; and this has ^{Pump.} therefore no peculiar merit.

The following will, we presume, appear vastly preferable. ABCD (fig. 24.) is the solid wooden or metal ⁵⁹ block of the piston; EF is a metal plate, which is turned hollow or dish-like below, so as to receive within it ^{Another recommended as preferable,} the solid block. The piston rod goes through the whole, and has a shoulder above the plate EF, and a nut H below. Four screw-bolts, such as *ik*, *lm*, also go through the whole, having their heads *k*, *m* sunk into the block, and nuts above at *i*, *l*. The packing or stuffing, as it is termed by the workmen, is represented at NO. This is made as solid as possible, and generally consists of soft hempen twine well soaked in a mixture of oil, tallow, and rosin. The plate EF is gently screwed down, and the whole is then put into the barrel, fitting it as tight as may be thought proper. When it wears loose, it may be tightened at any time by screwing down the nuts *il*, which cause the edges of the dish to squeeze out the packing, and compress it against the barrel to any degree.

The greatest difficulty in the construction of a piston ⁶⁰ is to give a sufficient passage through it for the water, and yet allow a firm support for the valve, and fixture ^{Difficulties in constructing pistons,} for the piston rod. We shall see presently that it occasions a considerable expence of the moving power to force a piston with a narrow perforation through the water lodged in the working barrel. When we are raising water to a small height, such as 10 or 20 feet, the power so expended amounts to a fourth part of the whole, if the water-way in the piston is less than one-half of the section of the barrel, and the velocity of the piston two feet *per* second, which is very moderate. There can be no doubt, therefore, that metal pistons are preferable, because their greater strength allows much wider apertures.

The following piston, described and recommended ⁶¹ by Belidor, seems as perfect in these respects as the nature of things will allow. We shall therefore describe ^{Considerably removed in one described by Belidor.} it in the author's own words as a model, which may be adopted with confidence in the greatest works.

"The body of the piston is a truncated metal cone ^{Plate} CCXX (fig. 25.), having a small fillet at the greater ^{ccccxxvi.} end. Fig. 26 shows the profile, and fig. 27. the plan of its upper base; where appears a cross bar DD, pierced with an oblong mortise E for receiving the tail of the piston-rod. A band of thick and uniform leather AA (fig. 26. and 28.) is put round this cone, and secured by a brass hoop BB firmly driven on its smaller end, where it is previously made thinner to give room for the hoop.

"This piston is covered with a leather valve, fortified with metal plates GG (fig. 29.) These plates are wider than the hole of the piston, so as to rest on its rim. There are similar plates below the leather of a smaller size, that they may go into the hollow of the piston; and the leather is firmly held between the metal plates by screws H, H, which go through all. This is represented by the dotted circle IK. Thus the pressure of the incumbent column of water is supported by the plates GG, whose circular edges rest on the brim of the water-way, and thus straight edges rest on the cross bar DD of fig. 26. and 27. This valve is laid on the top of the conical box in such a manner that its middle FF rests on the cross bar. To bind all together, the

Pump. the end of the piston-rod is formed like a cross, and the arms MN (fig. 30.) are made to rest on the diameter FF of the valve, the tail EP going through the hole E in the middle of the leather, and through the mortise E of the cross bar of the box; and also through another bar QR (fig. 28. and 29.) which is notched into the lower brim of the box. A key V is then driven into the hole T in the piston-rod; and this wedges all fast. The bar QR is made strong; and its extremities project a little, so as to support the brass hoop BB which binds the leather band to the piston-box. The adjoining scale gives the dimensions of all the parts, as they were executed for a steam-engine near Condé, where the piston gave complete satisfaction."

62
Advantages of this piston.

This piston has every advantage of strength, tightness, and large water-way. The form of the valve (which has given it the name of the *butterfly-valve*) is extremely favourable to the passage of the water; and as it has but half the motion of a complete circular valve, less water goes back while it is shutting.

63
Another ingenious and useful piston described.

The following piston is also ingenious, and has a good deal of merit. OPPO (fig. 31.) is the box of the piston, having a perforation Q, covered above with a flat valve K, which rests in a metal plate that forms the top of the box. ABCBA is a stirrup of iron to which the box is fixed by screws *a, a, a, a*, whose heads are sunk in the wood. This stirrup is perforated at C, to receive the end of the piston-rod, and a nut H is screwed on below to keep it fast. DEFED is another stirrup, whose lower part at DD forms a hoop like the sole of a stirrup, which embraces a small part of the top of the wooden box. The lower end of the piston-rod is screwed; and before it is put into the holes of the two stirrups (through which holes it slides freely) a broad nut G is screwed on it. It is then put into the holes, and the nut H firmly screwed up. The packing RR is then wound about the piston as tight as possible till it completely fills the working barrel of the pump. When long use has rendered it in any degree loose, it may be tightened again by screwing down the nut G. This causes the ring DD to compress the packing between it and the projecting shoulder of the box at PP; and thus causes it to swell out, and apply itself closely to the barrel.

64
Another on a different principle.

We shall add only another form of a perforated piston; which being on a principle different from all the preceding, will suggest many others; each of which will have its peculiar advantages. OO in fig. 32. represents the box of this piston, fitted to the working barrel in any of the preceding ways as may be thought best. AB is a cross bar of four arms, which is fixed to the top of the box. CF is the piston-rod going through a hole in the middle of AB, and reaching a little way beyond the bottom of the box. It has a shoulder D, which prevents its going too far through. On the lower end there is a thick metal plate, turned conical on its upper side, so as to fit a conical seat PP in the bottom of the piston-box.

When the piston-rod is pushed down, the friction on the barrel prevents the box from immediately yielding. The rod therefore slips through the hole of the cross bar AB. The plate E, therefore, detaches itself from the box. When the shoulder D presses on the bar AB, the box must yield, and be pushed down the barrel, and the water gets up through the perforation.

When the piston-rod is drawn up again, the box does not move till the plate E lodged in the seat PP, and thus shuts the water-way; and then the piston lifts the water which is above it, and acts as the piston of a sucking pump.

This is a very simple and effective construction, and its advantages. 65

It has been much recommended by engineers of the first reputation, and is frequently used; and from its simplicity, and the great solidity of which it is capable, it seems very fit for great works. But it is evident that the water-way is limited to less than one-half of the area of the working-barrel. For if the perforation of the piston be one-half of the area, the diameter of the plate or ball EF must be greater; and therefore less than half the area will be left for the passage of the water by its sides.

We come now to consider the forms which may be given to the valves of a hydraulic engine. 66

The requisites of a valve are, that it shall be tight, of sufficient strength to resist the great pressures to which it is exposed, that it afford a sufficient passage for the water, and that it do not allow much to go back while it is shutting.

We have not much to add to what has been said already on this subject. The valves which accompany the pump of fig. 5. are called *clack valves*, and are of all the most obvious and common; and the construction described on that occasion is as perfect as any. We only add, that as the leather is at last destroyed at the hinge by such incessant motion, and it is troublesome, especially in deep mines, and under water, to undo the joint of the pump in order to put in a new valve, it is frequently annexed to a box like that of a piston, made a little conical on the outside, so as to fit a conical seat made for it in the pipe, as represented in fig. 33. and it has an iron handle like that of a basket, by which it can be laid hold of by means of a long grappling-hook let down from above. Thus it is drawn up; and being very gently tapered on the sides, it sticks very fast in its place.

The only defect of this valve is, that by opening very wide when pushed up by the stream of water, it allows a good deal to go back during its shutting again. In some great machines which are worked by a slow turning crank, the return of the piston is so very slow, that a sensible loss is incurred by this; but it is nothing like what Dr Defaguliers says, one-half of a cylinder whose height is equal to the diameter of the valve. — For in such machines, the last part of the upward stroke is equally slow, and the velocity of the water through the valve exceedingly small, so that the valve is at this time almost shut. 68

The butterfly-valve represented in figures 29, &c. is free from most of those inconveniences, and seems the most perfect of the clack valves. Some engineers make their great valves of a pyramidal form, consisting of four clacks, whose hinges are in the circumference of the water-way, and which meets with their points in the middle, and are supported by four ribs which rise up from the sides, and unite in the middle. This is an excellent form, affording the most spacious water-way, and shutting very readily. It seems to be the best possible for a piston. The rod of the piston is branched out on four sides, and the branches go through the piston-box, and are fastened below with screws. These branches 69

Utility of the butterfly-valves.

⁷⁰
Button valves
Pump. branches form the support for the four clacks. We have seen a valve of this form in a pump of six feet diameter, which discharged 20 hogheads of water every stroke, and made 12 strokes in a minute, raising the water above 22 feet.

There is another form of valve, called the *button* or *tail valve*. It consists of a plate of metal AB (fig. 34.) turned conical, so as exactly to fit the conical cavity *ab* of its box. A tail CD projects from the under side, which passes through a cross bar EF in the bottom of the box, and has a little knob at the end, to hinder the valve from rising too high.

⁷¹
Very useful;
This valve, when nicely made, is unexceptionable. It has great strength, and is therefore proper for all severe strains, and it may be made perfectly tight by grinding. Accordingly it is used in all cases where this is of indispensable consequence. It is most durable, and the only kind that will do for passages where steam or hot water is to go through. Its only imperfection is a small water-way; which, from what has been said, cannot exceed, nor indeed equal, one-half of the area of the pipe.

⁷²
Though somewhat imperfect in the water-way.
If we endeavour to enlarge the water-way, by giving the cone very little taper, the valve frequently sticks so fast in the seat that no force can detach them.— And this sometimes happens during the working of the machine; and the jolts and blows given to the machine in taking it to pieces, in order to discover what has been the reason that it has discharged no water, frequently detaches the valve, and we find it quite loose, and cannot tell what has deranged the pump. When this is guarded against, and the diminution of the water-way is not of very great consequence, this is the best form of a valve.

⁷³
A very simple valve described.
Analogous to this is the simplest of all valves, represented in fig. 35. It is nothing more than a sphere of metal A, to which is fitted a seat with a small portion BC of a spherical cavity. Nothing can be more effectual than this valve; it always falls into its proper place, and in every position fits it exactly. Its only imperfection is the great diminution of the water-way. If the diameter of the sphere does not considerably exceed that of the hole, the touching parts have very little taper, and it is very apt to stick fast. It opposes much less resistance to the passage of the water than the flat under-surface of the button-valve. N. B. It would be an improvement of that valve to give it a taper-shape below like a boy's top. The spherical valve must not be made too light, otherwise it will be hurried up by the water, and much may go back while it is returning to its place.

⁷⁴
A valve by Belidor uniting every requisite.
Belidor describes with great minuteness (vol. ii. p. 221, &c.) a valve which unites every requisite. But it is of such nice and delicate construction, and its defects are so great when this exactness is not attained, or is impaired by use, that we think it hazardous to introduce it into a machine in a situation where an intelligent and accurate artist is not at hand. For this reason we have omitted the description, which cannot be given in few words, nor without many figures; and desire our curious readers to consult that author, or peruse Dr Defagulier's translation of this passage. Its principle is precisely the same with the following rude contrivance, with which we shall conclude the descriptive part of this article.

Suppose ABCD (fig. 36.) to be a square wooden trunk. EF is a piece of oak-board, exactly fitted to the trunk in an oblique position, and supported by an iron pin which goes through it at I, one-third of its length from its lower extremity E. The two ends of this board are bevelled, so as to apply exactly to the sides of the trunk. It is evident, that if a stream of water comes in the direction BA, its pressure on the part IF of this board will be greater than that upon EI. It will therefore force it up and rush through, making it stand almost parallel to the sides of the trunk. To prevent its rising so far, a pin must be put in its way. When this current of water changes its direction, the pressure on the upper side of the board being again greatest on the portion IF, it is forced back again to its former situation; and its two extremities resting on the opposite sides of the trunk, the passage is completely stopped. This board therefore performs the office of a valve; and this valve is the most perfect that can be, because it offers the freest passage to the water, and it allows very little to get back while it is shutting; for the part IF brings up half as much water as IF allows to go down. It may be made extremely tight, by fixing two thin fillets H and G to the sides of the trunk, and covering those parts of the board with leather which applies to them; and in this state it perfectly resembles Belidor's fine valve.

⁷⁵
Another valve on the same principle.
⁷⁶
Description of an occasional pump easily constructed.
And this construction of the valve suggests, by the way, a form of an occasional pump, which may be quickly set up by any common carpenter, and will be very effectual in small heights. Let *abcde* (fig. 36.) be a square box made to slide along this wooden trunk without shake, having two of its sides projecting upwards, terminating like the gable-ends of a house. A piece of wood *e* is mortised into these two sides, and to this the piston-rod is fixed. This box being furnished with a valve similar to the one below, will perform the office of a piston. If this pump be immersed so deep in the water that the piston shall also be under water, we scruple not to say that its performance will be equal to any. The piston may be made abundantly tight by covering its outside neatly with soft leather. And as no pipe can be bored with greater accuracy than a very ordinary workman can make a square trunk, we presume that this pump will not be very deficient even for a considerable suction.

⁷⁷
The motion of water in pumps.
We now proceed to the last part of the subject, to consider the motion of water in pumps, in reference to the force which must be employed. What we have hitherto said with respect to the force which must be applied to a piston, related only to the sustaining the water at a certain height: but in actual service we must not only do this, but we must discharge it at the place of delivery in a certain quantity; and this must require a force superadded to what is necessary for its mere support at this height.

⁷⁸
An intricate subject.
This is an extremely intricate and difficult subject, and very imperfectly understood even by professed engineers. The principles on which this knowledge must be founded are of a much more abstruse nature than the ordinary laws of hydrostatics; and all the genius of Newton was employed in laying the foundation of this part of physical science. It has been much cultivated in the course of this century by the first mathematicians of Europe. Daniel and John Bernoulli have written very

Pump.
79
The theory
denomina-
ted Hydro-
dynamics,

very elaborate treatises on the subject, under the very apposite name of HYDRODYNAMICS; in which, although they have added little or nothing to the fundamental propositions established in some sort by Newton, and acquiesced in by them, yet they have greatly contributed to our progress in it by the *methods* which they have pursued in making application of those fundamental propositions to the most important cases. It must be acknowledged, however, that both these propositions, and the extensions given them by these authors, are supported by a train of argument that is by no means unexceptionable; and that they proceed on assumptions or postulates which are but nearly true in any case, and in many are inadmissible: and it remains to this hour a wonder or puzzle how these propositions and their results correspond with the phenomena which we observe.

But fortunately this correspondence does obtain to a certain extent. And it seems to be this correspondence chiefly which has given these authors, with Newton at their head, the confidence which they place in their respective principles and methods: for there are considerable differences among them in those respects; and each seems convinced that the others are in a mistake. Messieurs d'Alembert and De la Grange have greatly corrected the theories of their predecessors, and have proceeded on postulates which come much nearer to the real state of the case. But their investigations involve us in such an inextricable maze of analytical investigation, that even when we are again conducted to the light of day by the clue which they have given us, we can make no use of what we there discovered.

80
Though
imperfect
is very
useful.

But this theory, imperfect as it is, is of great service. It generalizes our observations and experiments, and enables us to compose a *practical doctrine* from a heap of facts which otherwise must have remained solitary and unconnected, and as cumbersome in their application as the characters of the Chinese writing.

81
Fundamen-
tal proposi-
tion.

The fundamental proposition of this practical hydrodynamics is, that water or any fluid contained in an open vessel of indefinite magnitude, and impelled by its weight only, will flow through a small orifice with the velocity which a heavy body would acquire by falling from the horizontal surface of the fluid. Thus, if the orifice is 16 feet under the surface of the water, it will issue with the velocity of 32 feet in a second.

Its velocity corresponding to any other depth h of the orifice under the surface, will be had by this easy proportion: "As the square root of 16 is to the square root of h ; so is 32 feet to the velocity required: or,

$$\text{alternately, } \sqrt{16} : 32 = \sqrt{h} : v, \text{ and } v = \frac{32\sqrt{h}}{\sqrt{16}} =$$

$\frac{32}{4} \sqrt{h} = 8 \sqrt{h}$: that is, multiply the square root of the height in feet by eight, and the product is the required velocity.

On the other hand, it frequently occurs, that we want to discover the depth under the surface which will produce a known velocity v . Therefore $\sqrt{h} = \frac{v}{8}$

and $h = \frac{v^2}{64}$: that is, divide the square of the velocity by 64, and the quotient is the depth wanted in feet.

This proposition is sufficient for all our purposes. For since water is nearly a perfect fluid, and propagates all impressions undiminished, we can, in place of any pressure of a piston or other cause, substitute a perpendicular column of water whose weight is equal to this pressure, and will therefore produce the same efflux.— Thus, if the surface of a piston is half a square foot, and it be pressed down with the weight of 500 pounds, and we would wish to know with what velocity it would cause the water to flow through a small hole, we know that a column of water of this weight, and of half a foot base, would be 16 feet high. And this proposition teaches us, that a vessel of this depth will have a velocity of efflux equal to 32 feet in a second.

If therefore our pressing power be of such a kind that it can continue to press forward the piston with the force of 500 pounds, the water will flow with this velocity, whatever be the size of the hole. All that remains is, to determine what change of *actual pressure* on the piston results from the motion of the piston itself, and to change the velocity of efflux in the subduplicate ratio of the change of actual pressure.

But before we can apply this knowledge to the circumstances which take place in the motion of water in pumps, we must take notice of an important modification of the fundamental proposition, which is but very obscurely pointed out by any good theory, but is established on the most regular and unexceptionable observation.

Pump.
82
Its utility

83

Remark
previous
to its ap-
plication.

If the efflux is made through a hole in a thin plate, and the velocity is computed as above, we shall discover the quantity of water which issues in a second by observing, that it is a prism or cylinder of the length indicated by the velocity, and having its transverse section equal to that of the orifice. Thus, in the example already given, supposing the hole to be a square inch, the solid contents of this prism, or the quantity of water issuing in a second, is $1 \times 32 \times 12$ cubic inches, or 384 cubic inches. This we can easily measure by receiving it in a vessel of known dimensions. Taking this method, we uniformly find a deficiency of nearly 38 parts in 100; that is, if we should obtain 100 gallons in any number of seconds, we shall in fact get only 62. This is a most regular fact, whether the velocities are great or small, and whatever be the size and form of the orifice. The deficiency increases indeed in a very minute degree with the velocities. If, for instance, the depth of the orifice be one foot, the discharge is $\frac{621}{1000}$; if it be 15 feet, the discharge is $\frac{1082}{1000}$.

This deficiency is not owing to a diminution of velocity; for the velocity may be easily and accurately measured by the distance to which the jet will go, if directed horizontally. This is found to correspond very nearly with the proposition, making a very small allowance for friction at the border of the hole, and for the resistance of the air. Sir Isaac Newton ascribed the deficiency with great justice to this, that the lateral columns of water, surrounding the column which is incumbent on the orifice, press towards the orifice, and contribute to the expence equally with that column. These lateral filaments, therefore, issue obliquely, crossing the motion of the central stream, and produce a contraction of the jet; and the whole stream does not acquire a parallel motion and its ultimate velocity till it

has

Pump.

Pump.

has got to some distance from the orifice. Careful observation showed him that this was really the case. But even his genius could not enable him to ascertain the motion of the lateral filaments by theory, and he was obliged to measure every thing as he saw it. He found the diameter of the jet at the place of the greatest contraction to be precisely such as accounted for the deficiency. His explication has been unanimously acquiesced in; and experiments have been multiplied to ascertain all those circumstances which our theory cannot determine *à priori*. The most complete set of experiments are those of Michelotti, made at Turin at the expense of the prince of Piedmont. Here jets were made of 1, 2, 3, and 4 inches diameter; and the water received into cisterns most accurately formed of brick, and lined with stucco. It is the result of these experiments which we have taken for a measure of the deficiency.

We may therefore consider the water as flowing through a hole of this contracted dimension, or substitute this for the real orifice in all calculations. For it is evident that if a mouth-piece (so to call it) were made, whose internal shape precisely tallied with the form which the jet assumes, and if this mouth-piece be applied to the orifice, the water will flow out without any obstruction. The vessel may therefore be considered as really having this mouth-piece.

Nay, from this we derive a very important observation, "that if, instead of allowing the water to flow through a hole of an inch area made in a thin plate, we make it flow through a hole in a thick plank, so formed that the external orifice shall have an inch area, but be widened internally agreeably to the shape which nature forms, both the velocity and quantity will be that which the fundamental proposition determines. Michelotti measured with great care the form of the great jets of three and four inches diameter, and found that the bounding curve was an elongated trochoid. He then made a mouth-piece of this form for his jet of one inch, and another for his jet of two inches; and he found the discharges to be $\frac{7}{8}$ and $\frac{8}{9}$; and he, with justice, ascribed the trifling deficiency which still remained, partly to friction and partly to his not having exactly suited his mouth-piece to the natural form. We imagine that this last circumstance was the sole cause: For, in the first place, the water in his experiments, before getting at his jet-holes, had to pass along a tube of eight inches diameter. Now a jet of four inches bears too great a proportion to this pipe; and its narrowness undoubtedly hindered the lateral columns from contributing to the efflux in their due proportion, and therefore rendered the jet less convergent. And, in the next place, there can be no doubt (and the observations of Daniel Bernoulli confirm it) but that this convergence begins within the vessel, and perhaps at a very considerable distance from the orifice. And we imagine, that if accurate observations could be made on the motion of the remote lateral particles within the vessel, and an internal mouth-piece were shaped according to the curve which is described by the remotest particle that we can observe, the efflux of water would almost perfectly tally with the theory. But indeed the coincidence is already sufficiently near for giving us very valuable information. We learn that the quantity of water which flows through a hole, in consequence of its own weight, or by the action of any force, may be

increased one half by properly shaping the passage to this hole; for we see that it may be increased from 62 to near 99.

But there is another modification of the efflux, which we confess our total incapacity to explain. If the water issues through a hole made in a plate whose thickness is about twice the diameter of the hole, or, to express it better, if it issues through a pipe whose length is about twice its diameter, the quantity discharged is nearly $\frac{8}{10}$ of what results from the proposition. If the pipe be longer than this, the quantity is diminished by friction, which increases as the length of the pipe increases. If the pipe be shorter, the water will not fill it, but detaches itself at the very entry of the pipe, and flows with a contracted jet. When the pipe is of this length, and the extremity is stopped with the finger, so that it begins to flow with a full mouth, no subsequent contraction is observed; but merely striking on the pipe with a key or the knuckle is generally sufficient to detach the water in an instant from the sides of the pipe, and reduce the efflux to $\frac{6}{10}$.

This effect is most unaccountable. It certainly arises from the mutual adhesion or attraction between the water and the sides of the pipe; but how this, acting at right angles to the motion, should produce an increase from 62 to 82, nearly $\frac{1}{4}$, we cannot explain. It shows, however, the prodigious force of this attraction, which in the space of two or three inches is able to communicate a great velocity to a very great body of water. Indeed the experiments on capillary tubes show that the mutual attraction of the parts of water is some thousands of time greater than their weight.

We have only further to add, that every increase of pipe beyond two diameters is accompanied with a diminution of the discharge; but in what ratio this is diminished it is very difficult to determine. We shall only observe at present that the diminution is very great. A pipe of 2 inches diameter and 30 feet long has its discharge only $\frac{4}{10}$ of what it would be if only 4 inches long. If its length be 60 feet, its discharge will be no more than $\frac{3}{10}$. A pipe of 1 inch diameter would have a discharge of $\frac{4}{10}$, and $\frac{3}{10}$, in the same situation. Hence we may conclude that the discharge of a 4-inch pipe of 30 feet long will not exceed $\frac{2}{3}$ of what it would be if only 8 inches long. This will suffice for our present purposes; and the determination of the velocities and discharges in long conduits from pump-machines must be referred to the article *WATER-Works*. At present we shall confine our attention to the pump itself, and to what will contribute to its improvement.

Before we can proceed to apply this fundamental proposition to our purpose, we must anticipate in a loose way a proposition of continual use in the construction of *WATER-Works*.

Let water be supposed stagnant in a vessel EFGH (fig. 37.) and let it be allowed to flow out by a cylindrical pipe HIKL, divided by any number of partitions B, C, D, &c. Whatever be the areas B, C, D, of these orifices, the velocity in the intermediate parts of the pipe will be the same; for as much passes through any one orifice in a second as passes through any other in the same time, or through any section of the intervening pipe. Let this velocity in the pipe be V, and let the area of the pipe be A. The velocity in the orifices

Pump. fices B, C, D, must be $\frac{VA}{B}$, $\frac{VA}{C}$, $\frac{VA}{D}$, &c. Let g be the velocity acquired in a second by a heavy body. Then, by the general proposition, the height of water in the vessel which will produce the velocity $\frac{VA}{B}$ in the first orifice alone, is $\frac{V^2 A^2}{2gB^2}$. After this passage the velocity is again reduced to V in the middle of the space between the first and second orifices. In the second orifice this velocity is changed to $\frac{VA}{C}$. This alone would have required a height of water $\frac{V^2 A^2}{2gC^2}$. But the water is already moving with the velocity V , which would have resulted from a height of water in vessel (which we shall, in the language of the art, call the HEAD OF WATER) equal to $\frac{V^2}{2g}$. Therefore there is only required a head of water $\frac{V^2 A^2}{2gC^2} - \frac{V^2}{2g}$, or $\frac{V^2}{2g} \times \frac{A^2}{C^2} - 1$. Therefore the whole height necessary for producing the efflux through both orifices, so as still to preserve the velocity V in the intervening pipe, is $\frac{V^2}{2g} \times \frac{A^2}{B^2} + \frac{A^2}{C^2} - 1$. In like manner the third orifice D would alone require a head of water $\frac{V^2}{2g} \times \frac{A^2}{D^2} - 1$; and all the three would require a head $\frac{V^2}{2g} \times \frac{A^2}{B^2} + \frac{A^2}{C^2} + \frac{A^2}{D^2} - 2$. By this induction may easily be seen what head is necessary for producing the efflux through any number of orifices.

Let the expence or quantity of water discharged in an unit of time (suppose a second) be expressed by the symbol Q . This is measured by the product of the velocity by the area of the orifice, and is therefore $= VA$, or $\frac{VA}{B} \times B$, or $\frac{VA}{C} \times C$, &c. and $V = \frac{Q^2}{A^2}$. Therefore we may compute the head of water (which we shall express by H) in reference to the quantity of water discharged, because this is generally the interesting circumstance. In this view we have $H = \frac{Q^2}{2gA^2} \times$

$\frac{A^2}{B^2} + \frac{A^2}{C^2} + \frac{A^2}{D^2} - 2$: which shows that the head of water necessary for producing the discharge increases in the proportion of the square of the quantity of water which is discharged.

These things being premised, it is an easy matter to determine the motion of water in a pump, and the quantity discharged, resulting from the action of any force on the piston, or the force which must be applied to the piston in order to produce any required motion or quantity discharged. We have only to suppose that the force employed is the pressure of a column of water of the diameter of the working barrel; and this is over and above the force which is necessary for merely sup-

porting the water at the height of the place of delivery. **Pump.** The motion of the water will be the same in both cases.

Let us, first of all, consider a sucking-pump. ⁸⁵ The motion here depends on the pressure of the air, and will be the same as if the pump were lying horizontally, and communicated with a reservoir, in which is a head of water sufficient to overcome all the obstructions to the motion, and produce a velocity of efflux such as we desire. And here it must be noted that there is a limit. No velocity of the piston can make the water rise in the suction-pipe with a greater velocity than what would be produced by the pressure of a column of water 33 feet high; that is, about 46 feet per second.

Let the velocity of the piston be V , and the area of the working barrel be A . Then, if the water fills the barrel as fast as the piston is drawn up, the discharge during the rise of the piston, or the number of cubic feet of water per second, must be $= V \times A$. This is always supposed, and we have already ascertained the circumstances which ensure this to happen. If, therefore, the water arrived with perfect freedom to the piston, the force necessary for giving it this velocity, or for discharging the quantity $V \times A$ in a second, would be equal to the weight of the pillar of water whose height is $\frac{V^2}{2g}$, and base A .

It does not appear at first sight that the force necessary for producing this discharge has any thing to do with the obstructions to the ascent of the water into the pump, because this is produced by the pressure of the atmosphere, and it is the action of this pressure which is measured by the head of water necessary for producing the internal motion in the pump. But we must always recollect that the piston, before bringing up any water, and supporting it at a certain height, was pressed on both sides by the atmosphere. While the air supports the column below the piston, all the pressure expended in this support is abstracted from its pressure on the under part of the piston, while its upper part still supports the whole pressure. The atmosphere continues to press on the under surface of the piston, through the intermedium of the water in the suction-pipe, with the difference of these two forces.—Now, while the piston is drawn up with the velocity V , more of the atmospheric pressure must be expended in causing the water to follow the piston; and it is only with the remainder of its whole pressure that it continues to press on the under surface of the piston. Therefore, in order that the piston may be raised with the velocity V , a force must be applied to it, over and above the force necessary for merely supporting the column of water, equal to that part of the atmospheric pressure thus employed; that is, equal to the weight of the head of water necessary for forcing the water up through the suction-pipe, and producing the velocity V in the working barrel.

Therefore let B be the area of the mouth of the suction-pipe, and C the area of the fixed valve, and let the suction-pipe be of equal diameter with the working barrel. The head necessary for producing the velocity V on the working barrel is $\frac{V^2}{2g} \left(\frac{A^2}{B^2} + \frac{A^2}{C^2} - 1 \right)$. If d express the density of water; that is, if d be the number

Pump. number of pounds in a cubic foot of water, then $dA \frac{V^2}{2g}$ will express the weight of a column whose base is A , and height $\frac{V^2}{2g}$, all being reckoned in feet. Therefore the force which must be applied, when estimated in pounds, will be $p = \frac{dAV^2}{2g} \left(\frac{A^2}{B^2} + \frac{A^2}{C^2} - 1 \right)$

The first general observation to be made on what has been said is, that the power which must be employed to produce the necessary motion, in opposition to all the obstacles, is in the proportion of the square of the velocity which we would produce, or the square of the quantity of water we would discharge.

We have hitherto proceeded on the supposition, that there is no contraction of the jet in passing through these two orifices. This we know would be very far from the truth. We must therefore accommodate things to these circumstances, by diminishing B and C in the ratio of the contraction, and calling the diminished areas b and c ; then we have $p = \frac{dAV^2}{2g} \left(\frac{A^2}{b^2} + \frac{A^2}{c^2} - 1 \right)$.

What this diminution may be, depends on the form of the parts. If the fixed valve, and the entry into the pump, are simply holes in thin plates, then $b = \frac{62}{100} B$ and $c = \frac{62}{100} C$. The entry is commonly widened or trumpet-shaped, which diminishes greatly the contraction: but there are other obstacles in the way, arising from the strainer usually put round it to keep out filth. The valve may have its contraction greatly diminished also by its box being made bell-shaped internally; nay, even giving it a cylindrical box, in the manner of fig. 33. is better than no box at all, as in fig. 5.; for such a cylindrical box will have the unaccountable effect of the short tube, and make $b = \frac{82}{100} B$, instead of $\frac{62}{100} B$. Thus we see that circumstances seemingly very trifling may produce great effects in the performance of a pump. We should have observed that the valve itself presents an obstacle which diminishes the motion, and requires an increase of power; and it would seem that in this respect the clack or butterfly valve is preferable to the button valve.

Example. Suppose the velocity of the piston to be 2 feet or 24 inches per second, and that the two contracted areas are each $\frac{1}{2}$ of the area of the pump, which is not much less than what obtains in ordinary pumps.

We have $\frac{V^2}{2g} \left(\frac{A^2}{b^2} + \frac{A^2}{c^2} - 1 \right) = \frac{576}{100} (25 + 25 - 1) = 36.75$ inches, and the force which we must add to what will merely support the column is the weight of a pillar of water incumbent on the piston, and something more than three feet high. This would be a sensible portion of the whole force in raising water to small heights.

We have supposed the suction-pipe to be of the same diameter with the working barrel; but it is usual to make it of smaller diameter, generally equal to the water way of the fixed valve. This makes a considerable change in the force necessary to be applied to the piston. Let a be the area of the suction-pipe, the area of the entry being still B ; and the equivalent entry without contraction being still b , we have the velocity at the entrance $= \frac{AV}{b}$, and the producing head of water $=$

$\frac{A^2 V^2}{2g b^2}$. After this the velocity is changed to $\frac{AV}{a}$ in Pump. the suction-pipe, with which the water arrives at the valve, where it is again changed to $\frac{AV}{c}$, and requires for this change a head of water equal to $\frac{A^2 V^2}{2g c^2}$. But the velocity retained in the suction-pipe is equivalent to the effect of a head of water $\frac{A^2 V^2}{2g a^2}$. Therefore the head necessary for producing such a current through the fixed valve, that the water may follow the piston with the velocity V , is $\frac{A^2 V^2}{2g b^2} + \frac{A^2 V^2}{2g c^2} - \frac{A^2 V^2}{2g a^2}$, or $= \frac{V^2}{2g} \left(\frac{A^2}{b^2} + \frac{A^2}{c^2} - \frac{A^2}{a^2} \right)$. This is evidently less than

before, because a is less than A , and therefore $\frac{A^2}{a^2}$ is greater than unity, which was the last term of the former formula. There is some advantage, therefore, derived from making the diameter of the suction-pipe less than that of the working barrel: but this is only because the passage of the fixed valve is smaller, and the inspection of the formula plainly points out that the area of the suction-pipe should be equal to that of the fixed valve. When it is larger, the water must be accelerated in its passage through the valve; which is an useless expence of force, because this velocity is to be immediately reduced to V in the working-barrel. If the foregoing example be computed with a equal to $\frac{1}{2}$ of A , we shall find the head H equal to 29 inches instead of 37.

But this advantage of a smaller suction-pipe is in all cases very moderate; and the pump is always inferior to one of uniform dimensions throughout, having the orifice at the fixed valve of the same area. And if these orifices are considerably diminished in any proportion, the head necessary for overcoming the obstacles, so that the required velocity V may still be produced in the working barrel, is greatly increased. If we suppose the area $a \frac{1}{2}$ of A , which is frequently done in house pumps, where the diameter of the suction-pipe does seldom exceed $\frac{1}{2}$ of that of the working-barrel; and suppose every thing made in proportion to this, which is also usual, because the unskilled pump-makers study a symmetry which satisfies the eye; we shall find that the pump taken as an example will require a head of water $= 13$ feet and upwards. Besides, it must be observed that the friction of the suction-pipe itself has not been taken into the account. This alone is greater, in most cases, than all the obstructions we have been speaking of; for if this pipe is three inches diameter, and that of the working-barrel is six, which is reckoned a liberal allowance for a suction-pipe, and if the fixed valve is 25 feet above the surface of the pit-water; the friction of this pipe will amount to one-third of the whole propelling force.

Thus we have enabled the reader to ascertain the force necessary for producing any required discharge of water from a pump of known dimensions: and the converse of this determination gives us the discharge which will be produced by any given force. For making $\frac{A^2}{b^2} + \frac{A^2}{c^2} - \frac{A^2}{a^2}$, (which is a known quantity, resulting from the dimensions of the pump) $= M$, we

Pump. have $H = \frac{V^2}{2g} M$, and $V^2 = \frac{2gH}{M}$, and $V =$

$$\sqrt{\frac{2gH}{M}}. \text{ Now } H \text{ is that part of the natural power}$$

which we have at command which exceeds what is necessary for merely supporting the column of water. Thus, if we have a pump whose piston has an area of $\frac{1}{4}$ of a square foot, its diameter being $6\frac{1}{2}$ inches; and we have to raise the water 32 feet, and can apply a power of 525 pounds to the piston; we wish to know at what rate the piston will be moved, and the quantity of water discharged? Merely to support the column of water of this height and diameter, requires 500 pounds. Therefore the remaining power, which is to produce the motion, is 25 pounds. This is the weight of a column 1 foot 4 inches high, and $H = 1,333$ feet. Let us suppose the diameter of the suction-pipe $\frac{1}{2}$ of that of

the working-barrel, so that $\frac{A}{B} = 4$. We may suppose

it executed in the best manner, having its lower extremity trumpet-shaped, formed by the revolution of the proper trochoid. The contraction at the entry may

therefore be considered as nothing, and $\frac{A}{b} = 4$, and $\frac{A^2}{b^2}$

$= 16$. We may also suppose the orifice of the fixed

valve equal to the area of the suction-pipe, so that $\frac{A^2}{C^2}$

is also $= 16$, and there is no contraction here; and

therefore $\frac{A^2}{c^2}$ is also 16. And lastly, $\frac{A^2}{a^2}$ is also 16.

Therefore $\frac{A^2}{b^2} + \frac{A^2}{c^2} - \frac{A^2}{a^2}$ or $M = 16 + 16 - 16$,

$= 16$. We have also $2g = 64$. Now $V = \sqrt{\frac{2gH}{M}}$.

$= \sqrt{\frac{64 \times 1,333}{16}}$, $= 2,309$ feet, and the piston will

move with the velocity of 2 feet 4 inches nearly. Its velocity will be less than this, on account both of the friction of the piston and the friction of the water in the suction-pipe. These two circumstances will probably reduce it to one foot eight inches; and it can hardly be less than this.

We have taken no notice of the friction of the water in the working-barrel, or in the space above the piston; because it is in all cases quite insignificant. The longest pipes employed in our deep mines do not require more than a few inches of head to overcome it.

But there is another circumstance which must not be omitted. This is the resistance given to the piston in its descent. The pistons of an engine for drawing water from deep mines must descend again by their own weight in order to repeat their stroke. This must require a preponderance on that end of the working-beam to which they are attached, and this must be overcome by the moving power during the effective stroke. It makes, therefore, part of the whole work to be done, and must be added to the weight of the column of water which must be raised.

This is very easily ascertained. Let the velocity of the piston in its descent be V , the area of the pump-barrel A , and the area of the piston-valve a . It is evident, that while the piston descends with the velocity V , the water which is displaced by the piston in a second is $(A-a)V$. This must pass through the hole

of the piston, in order to occupy the space above, which is left by the piston. If there were no contraction, the Pump.

water would go thro' with the velocity $\frac{A-a}{a} V$; but as

there will always be some contraction, let the diminished area of the hole (to be discovered by experiment) be

b ; the velocity therefore will be $V \frac{A-a}{b}$. This re-

quires for its production a head of water $\frac{V^2}{2g} \left(\frac{A-a}{b} \right)^2$.

This is the height of a column of water whose base is not A but $A-a$. Calling the density of water d , we

have for the weight of this column, and the force p is

$$d \times A-a \times \left(\frac{A-a}{b} \right)^2 \times \frac{V^2}{2g} = \frac{d V^2 (A-a)^3}{2g b^2}.$$

This, we see again, is proportional to the square of the velocity of the piston in its descent, and has no relation to the height to which the water is raised.

If the piston has a button valve, its surface is at least equal to a ; and therefore the pressure is exerted on the

water by the whole surface of the piston. In this case

we shall have $p = \frac{d V^2 A^3}{2g b^2}$ considerably greater than

before. We cannot ascertain this value with great precision, because it is extremely difficult, if possible, to

determine the resistance in so complicated a case. But the formula is exact, if b can be given exactly; and

we know within very moderate limits what it may amount to. In a pump of the very best construction,

with a button valve, b cannot exceed one-half of A ; and therefore $\frac{A^3}{b^2}$ cannot be less than 8. In this

case, $\frac{V^2 A^3}{2g b^2}$ will be $\frac{V^2}{8}$. In a good steam-engine pump

V is about three feet per second, and $\frac{V^2}{8}$ is about $1\frac{1}{8}$

feet, which is but a small matter.

We have hitherto been considering the sucking-⁸⁶ And in the pump alone: but the forcing pump is of more importance, and apparently more difficult of investigation.—pump.

Here we have to overcome the obstructions in long

pipes, with many bends, contractions, and other ob-

structions. But the consideration of what relates merely

to the pump is abundantly simple. In most cases

we have only to force the water into an air-vessel, in op-

position to the elasticity of the air compressed in it, and

to send it thither with a certain velocity, regulated by

the quantity of water discharged in a given time. The

elasticity of the air in the air-vessel propels it along the

Main. We are not now speaking of the force necessary

for counterbalancing this pressure of the air in the

air-vessel, which is equivalent to all the subsequent ob-

structions, but only of the force necessary for propelling the

water out of the pump with the proper velocity. We have in a manner determined this already. The piston is solid, and the water which it forces has to pass through a valve in the lateral pipe, and then to move in the direction of the Main. The change of direction requires an addition of force to what is necessary for merely impelling the water through the valve. Its quantity is not easily determined by any theory, and it varies according to the abruptness of the turn. It appears from experiment, that when a pipe is bent to a right angle, without any curvature or rounding, the velocity is diminished about $\frac{1}{15}$. This would aug-

Pump. ment the head of water about $\frac{1}{4}$. This may be added to the contraction of the valve hole. Let c be its natural area, and whatever is the contraction competent to its form increase it $\frac{1}{16}$, and call the contracted area c . Then this will require a head of water $= \frac{V^2 A^2}{2 g c^2}$.

This must be added to the head $\frac{V^2}{2 g}$, necessary for merely giving the velocity V to the water. Therefore the whole is $\frac{V^2}{2 g} \left(\frac{A^2}{c^2} + 1 \right)$; and the power p necessary for this purpose is $\frac{d A V^2}{2 g} \left(\frac{A^2}{c^2} + 1 \right)$.

It cannot escape the observation of the reader, that in all these formulæ, expressing the height of the column of water which would produce the velocity V in the working barrel of the pump, the quantity which multiplies the constant factor $\frac{d A V^2}{2 g}$ depends on the

contracted passages which are in different parts of the pump, and increases in the duplicate proportion of the sum of those contractions. It is therefore of the utmost consequence to avoid all such, and to make the Main which leads from the forcing-pump equal to the working barrel. If it be only of half the diameter, it has but one-fourth of the area, the velocity in the Main is four times greater than that of the piston, and the force necessary for discharging the same quantity of water is 16 times greater.

It is not, however, possible to avoid these contractions altogether, without making the main pipe wider than the barrel. For if only so wide, with an entry of the same size, the valve makes a considerable obstruction. Unskilful engineers endeavour to obviate this by making an enlargement in that part of the Main which contains the valve. This is seen in fig. 14. at the valve L. If this be not done with great judgment, it will increase the obstructions. For if this enlargement is full of water, the water must move in the direction of its axis with a diminished velocity; and when it comes into the main, it must again be accelerated. In short, any abrupt enlargement which is to be afterwards contracted, does as much harm as a contraction, unless it be so short that the water in the axis keeps its velocity till it reaches the contraction. Nothing would do more service to an artist, who is not well founded in the theory of hydrodynamics, than to make a few simple and cheap experiments with a vessel like that of fig. 37. Let the horizontal pipe be about three inches diameter, and made in joints which can be added to each other. Let the joints be about six inches long, and the holes from one-fourth to a whole inch in diameter. Fill the vessel with water, and observe the time of its sinking three or four inches. Each joint should have a small hole in its upper side to let out the air; and when the water runs out by it, let it be stopped by a peg. He will see that the larger the pipe is in proportion to the orifices made in the partitions, the efflux is *more diminished*. We believe that no person would suspect this who has not considered the subject minutely.

All angular enlargements, all boxes, into which the pipes from different working barrels, unite their water before it goes into a Main, must therefore be avoided by an artist who would execute a good machine; and the different contractions which are unavoidable at

the seats of valves and the perforations of pistons, &c. Pump. should be diminished by giving the parts a trumpet-shape.

In the air-vessels represented in fig. 13. this is of very great consequence. The throat O, through which the water is forced by the expansion of the confined air, should always be formed in this manner. For it is this which produces the motion during the returning part of the stroke in the pump constructed like fig. 13. n° 1. and during the whole stroke in n° 2. Neglecting this seemingly trifling circumstance will diminish the performance at least one-fifth. The construction of n° 1. is the best, for it is hardly possible to make the passage of the other so free from the effects of contraction. The motion of the water during the returning stroke is very much contorted.

There is one circumstance that we have not taken any notice of, viz. the gradual acceleration of the motion of water in pumps. When a force is applied to the piston, it does not in an instant communicate all the velocity which it acquires. It acts as gravity acts on heavy bodies; and if the resistances remained the same, it would produce, like gravity, an uniformly accelerated motion. But we have seen that the resistances (which are always measured by the force which just overcomes them) increase as the square of the velocity increases. They therefore quickly balance the action of the moving power, and the motion becomes uniform, in a time so short that we commit no error of any consequence by supposing it uniform from the beginning. It would have prodigiously embarrassed our investigations to have introduced this circumstance; and it is a matter of mere speculative curiosity: for most of our moving powers are unequal in their exertions, and these exertions are regulated by other laws. The pressure on a piston moved by a crank is as variable as its velocity, and in most cases is nearly in the inverse proportion of its velocity, as any mechanician will readily discover. The only case in which we could consider this matter with any degree of comprehensibility is that of a steam-engine, or of a piston which forces by means of a weight lying on it. In both, the velocity becomes uniform in a very small fraction of a second.

We have been very minute on this subject. For although it is the only view of a pump which is of any importance, it is hardly ever understood even by professed engineers. And this is not peculiar to hydraulics, but is seen in all the branches of practical mechanics. The elementary knowledge to be met with in such books as are generally perused by them, goes no farther than to state the forces which are in equilibrium by the intervention of a machine, or the proportion of the parts of a machine which will set two known forces in equilibrio. But when this equilibrium is destroyed by the superiority of one of the forces, the machine must move; and the only interesting question is, *what will be the motion?* Till this is answered with some precision, we have learned nothing of any importance. Few engineers are able to answer this question even in the simplest cases; and they cannot, from any confident science, say what will be the performance of an untried machine. They guess at it with a success proportioned to the multiplicity of their experience and their own sagacity. Yet this part of mechanics is as susceptible of accurate computation as the cases of equilibrium. — We therefore thought it our duty to point out the manner of proceeding so circumstantially, that every

Pun
||
Puncheon

step should be plain and easy, and that conviction should always accompany our progress. This we think it has been in our power to do, by the very simple method of substituting a column of water acting by its weight in lieu of any natural power which we may chance to employ.

To such as wish to prosecute the study of this important part of hydraulics in its most abstruse parts, we recommend the perusal of the dissertations of Mr Pitot and Mr Bossut, in the Memoirs of the Academy of Paris; also the dissertations of the Chevalier De la Borda, 1766 and 1767; also the *Hydraulique* of the Chevalier De Buat. We shall have occasion to consider the motion of the water in the mains of forcing or lifting pumps which send the water to a distance, in the article *WATER-Works*; where the reader will see how small is the performance of all hydraulic machines, in comparison of what the usual theories, founded on equilibrium only, would make him expect.

PUN, or PUNN, an expression where a word has at once different meanings. The practice of punning is the miserable refuge of those who wish to pass for wits, without having a grain of wit in their composition.—James the I. of England delighted in punning; and the taste of the sovereign was studied by the courtiers, and even by the clergy. Hence the sermons of that age abound with this species of false wit. It continued to be more or less fashionable till the reign of Queen Anne, when Addison, Swift, Pope, and Arbuthnot, with the other real wits of that classical age, united their efforts to banish punning from polite composition. It is still admitted sparingly in conversation; and no one will deny that a happy pun, when it comes unsought, contributes to excite mirth in a company. A professed *punster*, however, who is always pouring forth his senseless quibbles, as Saucio Panca poured forth his proverbs, is such an intolerable nuisance in society, that we do not wonder at Pope or Swift having written a pamphlet with the title of *God's Revenge against Punning*.

PUNCH, an instrument of iron or steel, used in several arts, for the piercing or stamping holes in plates of metals, &c. being so contrived as not only to perforate, but to cut out and take away the piece. The punch is a principal instrument of the metal-button makers, shoe-makers, &c.

PUNCH is also a name for a sort of compound drink, much used here, and in many parts abroad, particularly in Jamaica, and several other parts of the West Indies.

Its basis is spring-water; which being rendered cooler, brisker, and more acid, with lemon or lime juice, and sweetened again to the palate with fine sugar, makes what they call *sherbet*; to which a proper quantity of spirituous liquor, as brandy, rum, or arrack, being added, the liquor commences punch.

PUNCHEON, PUNCHIN, or *Punchion*, a little block or piece of steel, on one end whereof is some figure, letter, or mark, engraven either in creux or relieve, impressions whereof are taken on metal, or some other matter, by striking it with a hammer on the end not engraved. There are various kinds of these puncheons used in the mechanical arts; such, for instance, are those of the goldsmiths, cutlers, pewterers, &c.

The puncheon, in coining, is a piece of iron steeled,

whereon the engraver has cut in relieve the several figures, arms, effigy, inscription, &c. that there are to be in the matrices, wherewith the species are to be marked. Minters distinguish three kinds of puncheons, according to the three kinds of matrices to be made; that of the effigy, that of the cross or arms, and that of the legend or inscription. The first includes the whole portrait in relieve; the second are small, such only containing a piece of the cross or arms; for instance, a fleur-de-lis, an harp, a coronet, &c. by the assemblage of all which the entire matrix is formed. The puncheons of the legend only contain each one letter, and serve equally for the legend on the effigy side and the cross side. See the article COINAGE.

For the puncheons used in stamping the matrices wherein the types of printing characters are cast, see *Letter-Foundry*.

PUNCHEON is also used for several iron tools, of various sizes and figures, used by the engravers en creux on metals. Seal-gravers particularly use a great number for the several pieces of arms, &c. to be engraven, and many stamp the whole seal from a single puncheon.

PUNCHEON, is also a common name for all those iron instruments used by stone-cutters, sculptors, blacksmiths, &c. for the cutting, incising, or piercing their several matters.

Those of sculptors and statuaries serve for the repairing of statues when taken out of the moulds. The locksmiths use the greatest variety of puncheons; some for piercing hot, others for piercing cold; some flat, some square, some round, others oval, each to pierce holes of its respective figure in the several parts of locks.

PUNCHEON, in carpentry, is a piece of timber placed upright between two posts, whose bearing is too great; serving, together with them, to sustain some large weights.

This term is also used for a piece of timber raised upright, under the ridge of a building, wherein the legs of a couple, &c. are jointed.

PUNCHEON, is also the name of a measure for liquids. Rum is brought from the colonies in puncheons, which are large casks containing about 130 gallons.

PUNCTUATION, in grammar, the art of pointing, or of dividing a discourse into periods, by points expressing the pauses to be made therein.

The points used are four, viz. the period, colon, semi-colon, and comma. See the particular use of each under its proper article, COMMA, COLON, PERIOD, and SEMI-COLON.

In the general, we shall only here observe, that the comma is to distinguish nouns from nouns, verbs from verbs, and such other parts of a period as are not necessarily joined together.—The semi-colon serves to suspend and sustain the period when too long:—the colon, to add some new, supernumerary reason, or consequence, to what is already said:—and the period, to close the sense and construction, and release the voice.

Punctuation is a modern art. The ancients were entirely unacquainted with the use of our commas, colons, &c. and wrote not only without any distinction of members and periods, but also without distinction of words.

Puncheon
||
Punctuation.

Punctua-
tion.Punctum
||
Punica.

words: which custom, Lipsius observes, continued till the hundred and fourth Olympiad; during which time the sense alone divided the discourse.

What within our own knowledge at this day puts this beyond dispute, is the Alexandrian manuscript, which is at present in the king's library at the British Museum. Whoever examines this, will find, that the whole is written *continuo ductu*, without distinction of words or sentences. How the ancients read their works written in this manner, it is not easy to conceive.

After the practice of joining words together ceased, notes of distinction were placed at the end of every word. In all the editions of the *Fassii Capitolini* these points occur. The same are to be seen on the *Columna Rostrata*. For want of these, we find much confusion in the *Chronicon Marmoreum*, and the covenant between the Smyrnæans and Magnesians, which are both now at Oxford. In Salmassius's edition of *Dedicatio statue rigilla Herodis*, the like confusion occurs, where we find ΔΕΥΠΙΤΕ and ΔΕΥΠΙΤΕ.

Of these marks of distinction, the Walcote inscription found near Bath may serve for a specimen:

IVLIUS VITALIS FABRI
CESIS LEG XXV V V
STIPENDIORUM &c.

After every word here, except at the end of a line, we see this mark v. There is an inscription in Mount-faucon, which has a capital letter laid in an horizontal position, by way of interstitial mark, which makes one apt to think that this way of pointing was sometimes according to the fancy of the graver.

P. FERRARIUS HERMES
CAECINIAE ⇨ DIGNAE
CONIVGI ⇨ KARRISSIMAE
NVMERIAE ⇨ &c.

Here we observe after the words a T laid horizontally, but not after each word, which proves this to be of a much later age than the former.

Having now considered that the present usage of stops was unknown to the ancients, we proceed to assign the time in which this useful improvement of language began.

As it appears not to have taken place while manuscripts and monumental inscriptions were the only known methods to convey knowledge, we must conclude that it was introduced with the art of printing. The 14th century, to which we are indebted for this invention, did not, however, bestow those appendages we call *stops*: whoever will be at the pains to examine the first printed books, will discover no stops of any kind; but arbitrary marks here and there, according to the humour of the printer. In the 15th century, we observe their first appearance. We find, from the books of this age, that they were not all produced at the same time; those we meet with there in use, being only the comma, the parenthesis, the interrogation, and the full point. To prove this, we need but look into Bale's Acts of English Votaries, black-letter, printed 1550. Indeed, in the dedication of this book, which is to Edward VI. we discover a colon: but, as this is the only one of the kind throughout the work, it is plain this stop was not established at this time, and so warily put in by the printer; or if it was, that it was not in common use. Thirty years after this time, in that sensible and judicious performance of Sir Thomas Elyot, entitled *The Governour*, imprinted

1580, we see the colon as frequently introduced as any other stop; but the semi-colon and the admiration were still wanting, neither of these being visible in this book. In Hackluyt's voyages, printed 1599, we see the first instance of a semi-colon: and, as if the editors did not fully apprehend the propriety of its general admission, it is but sparingly introduced. The admiration was the last stop that was invented; and seems to have been added to the rest in a period not so far distant from our own time.

Thus we see, that these notes of distinction came into use as learning was gradually advanced and improved; one invention indeed, but enlarged by several additions.

PUNCTUM SALIENS, in anatomy, the first rudiments of the heart in the formation of the foetus, where a throbbing motion is perceived. This is said to be easily observed with a microscope in a brood-egg, wherein, after conception, we see a little speck or cloud, in the middle whereof is a spot that appears to beat or leap a considerable time before the foetus is formed for hatching. See the article FOETUS, and ANATOMY, p. 741, &c.

PUNCTUM FLANS, a phrase by which the schoolmen vainly attempted to bring within the reach of human comprehension the positive eternity of God. Those subtle reasoners seem to have discovered that nothing, which is made up of parts whether continuous or discrete, can be absolutely infinite, and that therefore eternity cannot consist of a boundless series of successive moments. Yet, as if such a series had always existed and were commensurate in duration with the supreme Being, they compared his eternity to one of the moments which compose the flux of time arrested in its course; and to this eternal moment they gave the name of *punctum flans*, because it was supposed to stand still, whilst the rest followed each other in succession, all vanishing as soon as they appeared. We need not waste time or room in exposing the absurdity of this conceit, as we have elsewhere endeavoured, in the best manner that we can, to ascertain the meaning of the words *eternity* and *infinity*, and to show that they cannot be predicated of time or space, of points or moments, whether flowing or standing still. (See METAPHYSICS, Part II. chap. 7. 8. and Part III. chap. 6.)

PUNCTURE, in surgery, any wound made by a sharp-pointed instrument.

PUNCTURE, in farriery. See there, § xl. 3.

PUNDITS, or PENDITS, learned Bramins devoted to the study of the Sanscrit language, and to the ancient science, laws, and religion of Hindostan. See PHILOSOPHY, II 4—12.

PUNICA, the POMEGRANATE TREE: A genus of the monogynia order, belonging to the icosaandria class of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid superior; there are five petals; the fruit is a multilocular and polyspermous apple.

Species. 1. The granatum, or common pomegranate, rises with a tree stem, branching numerously all the way from the bottom, growing 18 or 20 feet high; with spear-shaped, narrow opposite leaves; and the branches terminated by most beautiful large red flowers, succeeded by large roundish fruit as big as an orange, having a hard rind filled with soft pulp and numerous seeds. There is a variety with double flowers, remarkably

Punish-
ment
||
Purcell.

ably beautiful; and one with striped flowers. 2. The nana, or dwarf American pomegranate, rises with a shrubby stem branching four or five feet high, with narrow short leaves and small red flowers, succeeded by small fruit; begins flowering in June, and continues till October.

Culture. Both these species are propagated by layers: the young branches are to be chosen for this purpose, and autumn is the proper time for laying them. Those of the common sort may be trained either as half or full standards, or as dwarfs. But those designed for walls must be managed as directed for peaches.

Uses. The dried flowers of the double-flowered pomegranate are possessed of an astringent quality; for which reason they are recommended in diarrhoeas, dysenteries, &c. where astringent medicines are proper. The rind of the fruit is also a strong astringent, and as such is occasionally made use of.

PUNISHMENT, in law, the penalty which a person incurs on the commission of a crime. See the article *CRIME and Punishment*.

The ingenuity of men has been much exerted to torment each other; but the following are the punishments that have been usually adopted in the different countries of the world. The capital punishments have been beheading, crucifixion, burning, roasting, drowning, scalping, hanging by the neck, the arm, or the leg, starving, sawing, exposing to wild beasts, rending asunder by horses drawing opposite ways, burying alive, shooting, blowing from the mouth of a cannon, compulsory deprivation of sleep, rolling in a barrel stuck with nails pointed inwards, poisoning, pressing slowly to death by a weight laid on the breast, casting headlong from a rock, tearing out the bowels, pulling to pieces with red-hot pincers, the rack, the wheel, impaling, flaying alive, &c. &c.

The punishments short of death have been, fine, pillory, imprisonment, compulsory labour at the mines, galleys, highways, or correction-house; whipping, bastonading, mutilation by cutting away the ears, the nose, the tongue, the breasts of women, the foot, the hand; squeezing the marrow from the bones with screws or wedges, castration, putting out the eyes, banishment, running the gauntlet, drumming, shaving off the hair, burning on the hand or forehead, &c.

PUNNING. See **PUN**.

PUPIL, in the civil law, a boy or girl not yet arrived at the age of puberty; i. e. the boy under 14 years, the girl under 12.

PUPIL is also used in universities, &c. for a youth under the education or discipline of any person.

PUPIL, in anatomy, a little aperture in the middle of the uvea and iris of the eye, through which the rays of light pass to the crystalline humour, in order to be painted on the retina, and cause vision. See **ANATOMY**, p. 765, &c.

PURCELL (Henry), a justly celebrated master of music, began early to distinguish himself. As his genius was original, it wanted but little forming, and he rose to the height of his profession with more ease than others pass through their rudiments. He was made organist to Westminster abbey in the latter end of the reign of Charles II. In that of William, he set several songs for Dryden's *Amphytrion* and his *King Arthur*, which were received with just applause. His notes in

his operas were admirably adapted to his words, and so echoed to the sense, that the sounds alone seemed capable of exciting those passions which they never failed to do in conjunction. His music was very different from the Italian. It was entirely English, and perfectly masculine. His principal works have been published under the title of *Orpheus Britannicus*. He died in 1695, in the 37th year of his age; and was interred in Westminster abbey, where a monument is erected to his memory.

PURCHAS (Samuel), an English divine, famous for compiling a valuable collection of voyages, was born in 1577, at Thacksted in Essex. After studying at Cambridge, he obtained the vicarage of Eastwood in his native county; but leaving that cure to his brother, he settled in London, in order to carry on the great work in which he was engaged. He published the first volume in folio in 1613, and the four last, 12 years after, under the title of *Purchas his Pilgrimage, or Relations of the world, and the Religions observed in all ages and places*. Meanwhile he was collated to the rectory of St Martin's, Ludgate, in London, and made chaplain to Dr Abbot, archbishop of Canterbury. His *Pilgrimage*, and the learned Hackluyt's *Voyages*, led the way to all the other collections of that kind, and have been justly valued and esteemed. But unhappily, by his publishing, he involved himself in debt: however, he did not die in prison, as some have asserted; but at his own house, about the year 1628.

PURCHASE, in law, the buying or acquiring of lands, &c. with money, by deed or agreement, and not by descent or right of inheritance.

PURCHASE, in the sea-language, is the same as *draw in*: thus, when they say, the capstan purchases a-pace, they only mean, it draws in the cable a-pace.

PURE, something free from any admixture of foreign or heterogeneous matters.

PURFLEW, a term in heraldry, expressing ermins, peans, or any of the furs, when they compose a bordure round a coat of arms: thus they say, He beareth gules, a bordure, purflew, vairy; meaning, that the bordure is vairy.

PURGATION, the art of purging, scouring, or purifying a thing, by separating, or carrying off any impurities found therein. Thus,

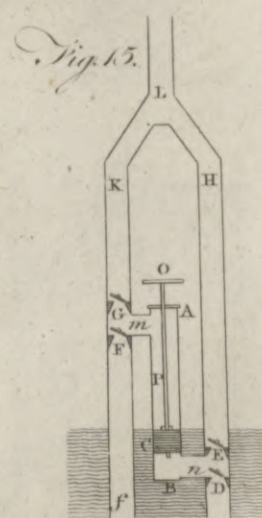
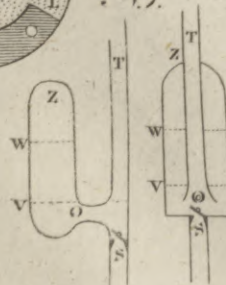
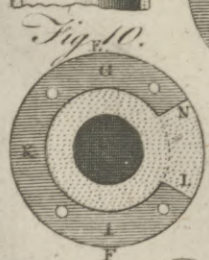
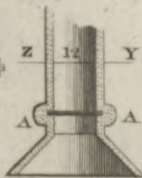
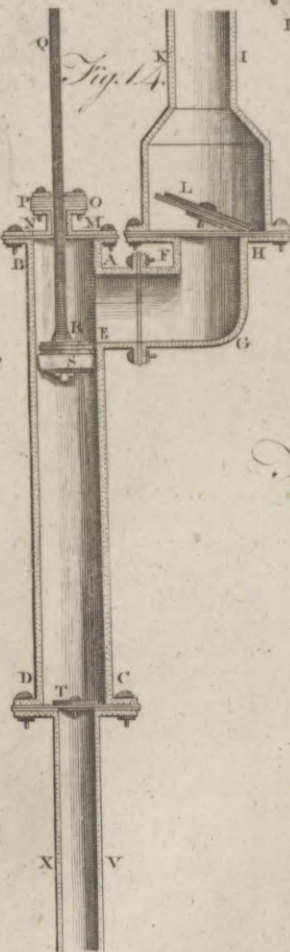
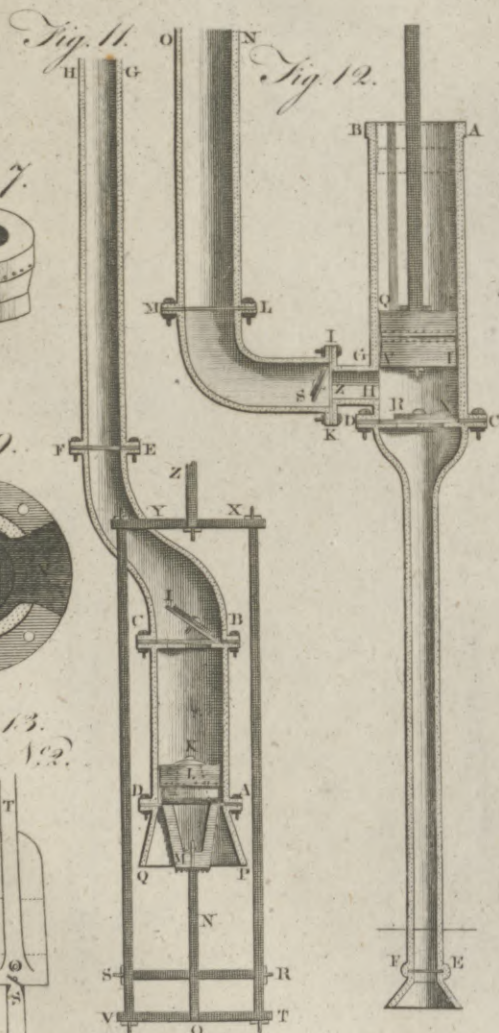
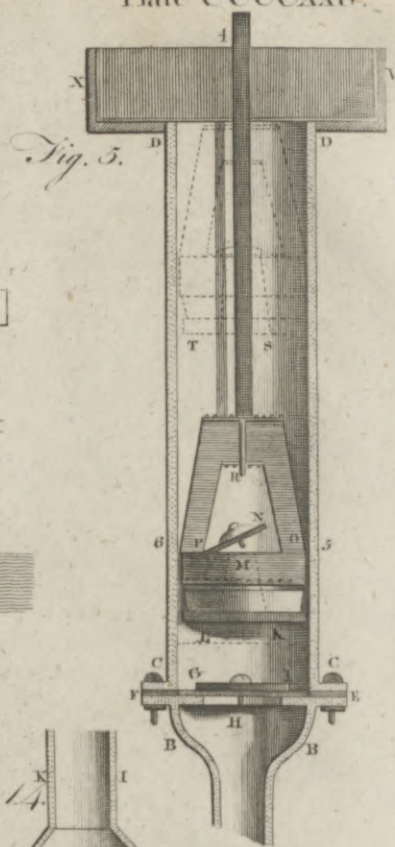
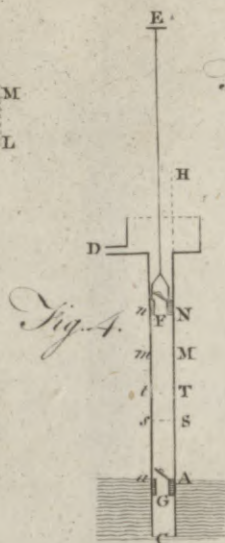
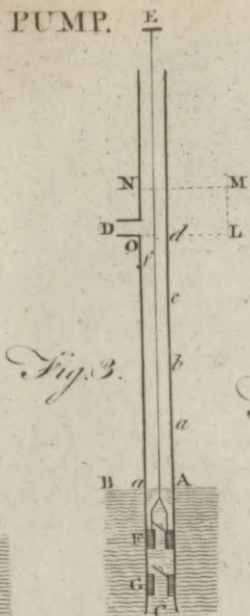
In pharmacy, purgation is the cleansing of a medicine by retrenching its superfluities. In chemistry, it is used for the several preparations of metals and minerals intended to clear them of their impurities, more usually called *purification* and *refining*. See **REFINING**.

In medicine, purgation is an excretory motion arising from a quick and orderly contraction of the fleshy fibres of the stomach and intestines, whereby the chyle, corrupted humours, and excrements lodged therein, are protruded further and further, and at length quite excluded the body by stool. See **MATERIA MEDICA**.

For the menstrual purgation of women, see **MENSES**.

PURGATION, in law, signifies the clearing a person's self of a crime of which he is suspected and accused before a judge. This purgation is either canonical or vulgar. Canonical purgation is prescribed by the canon-law, and the form thereof in the spiritual court is usually thus: The person suspected takes his oath that he is innocent of the crime charged against him; and at the same

Purchas
||
Purgation.



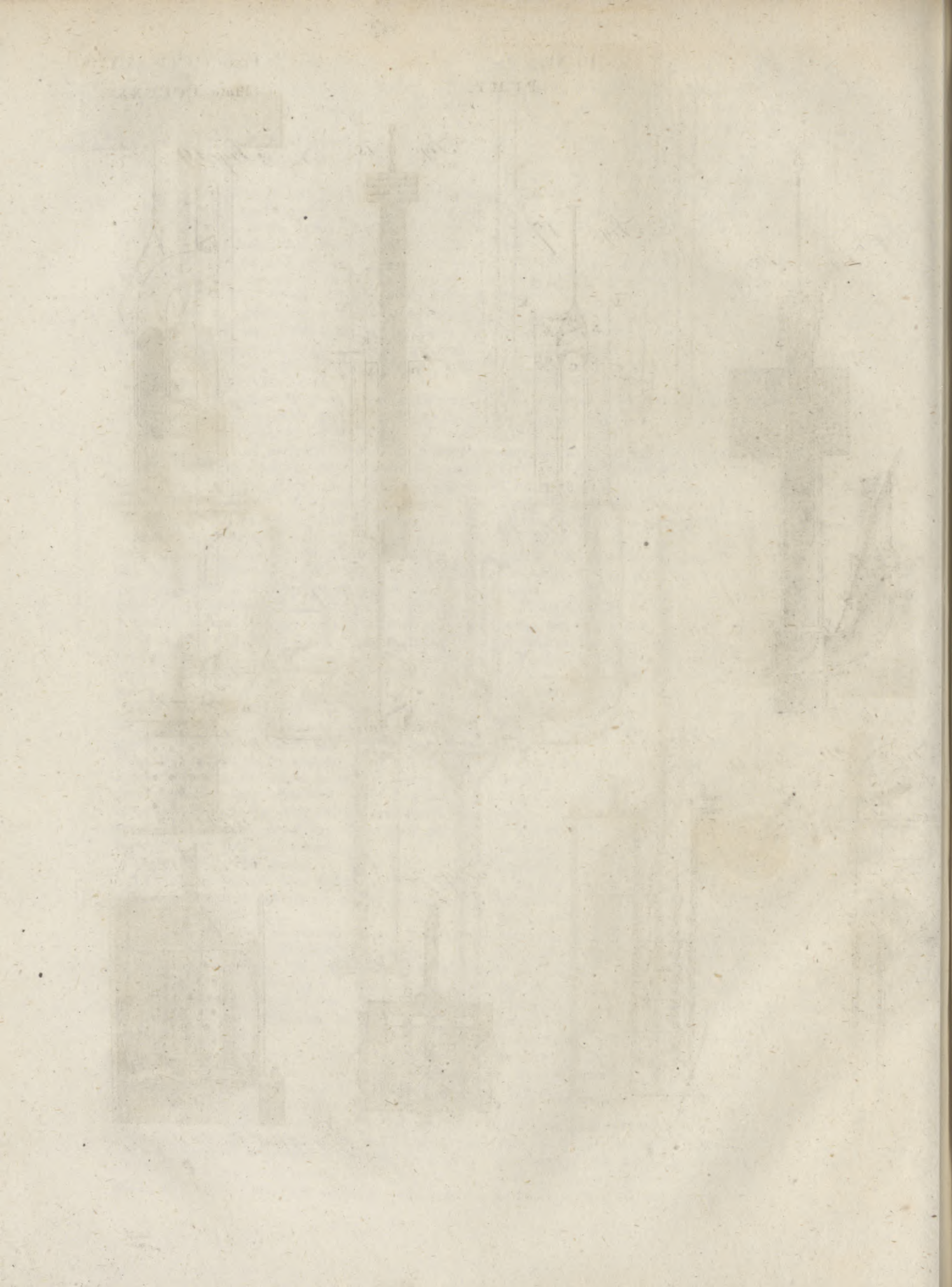


Fig. 18.



Fig. 19.



Fig. 17.

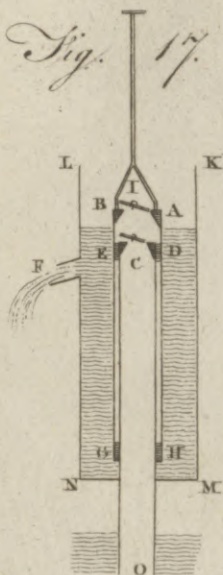


Fig. 16.

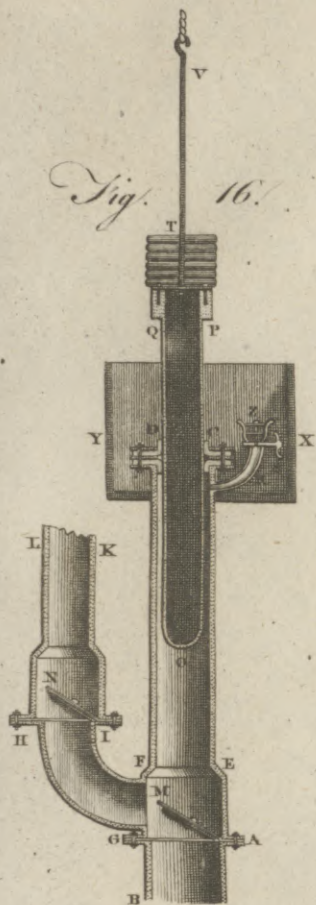


Fig. 21.

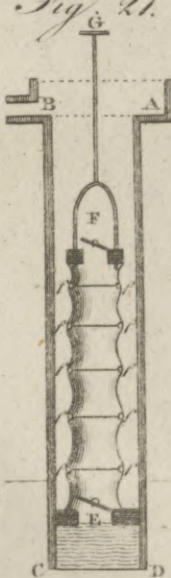


Fig. 23.

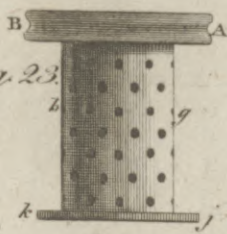


Fig. 24.

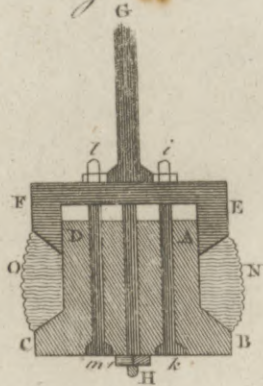


Fig. 22.

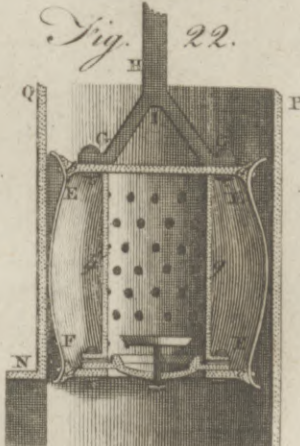
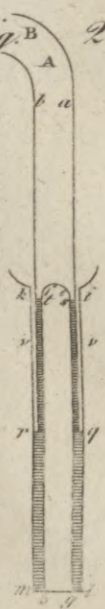


Fig. 20.



PUMP.

Plate CCCCXXVI.

Fig. 25.

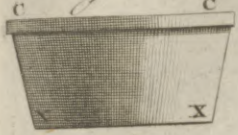


Fig. 26.



Fig. 30.

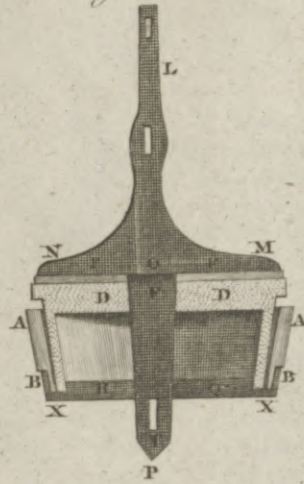


Fig. 27.

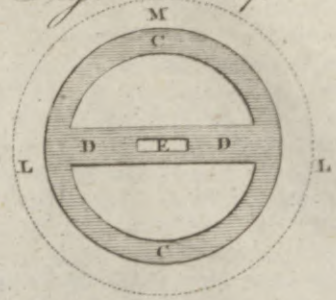


Fig. 28.

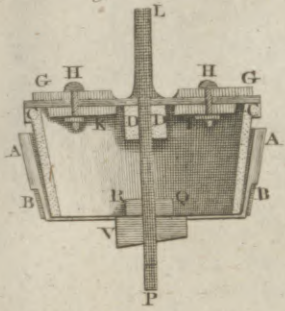


Fig. 29.



Fig. 34.

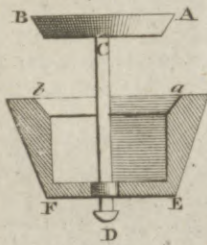


Fig. 31.

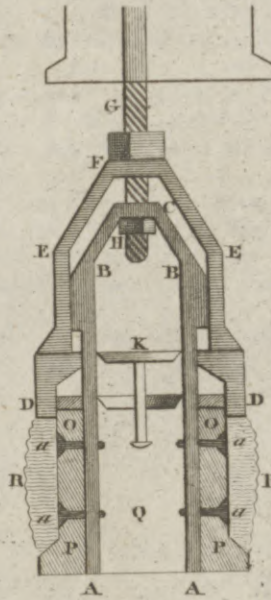


Fig. 32.

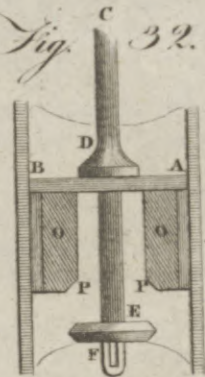


Fig. 33.



Fig. 36.

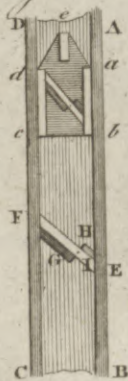


Fig. 35.

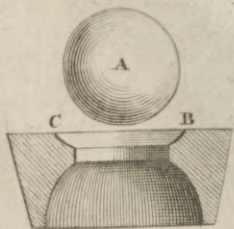
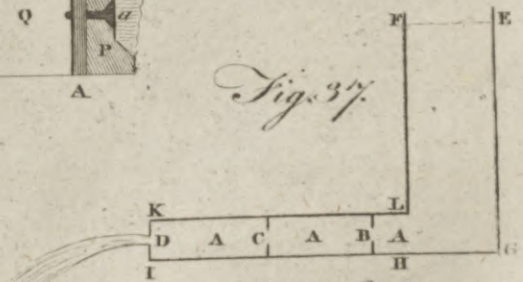
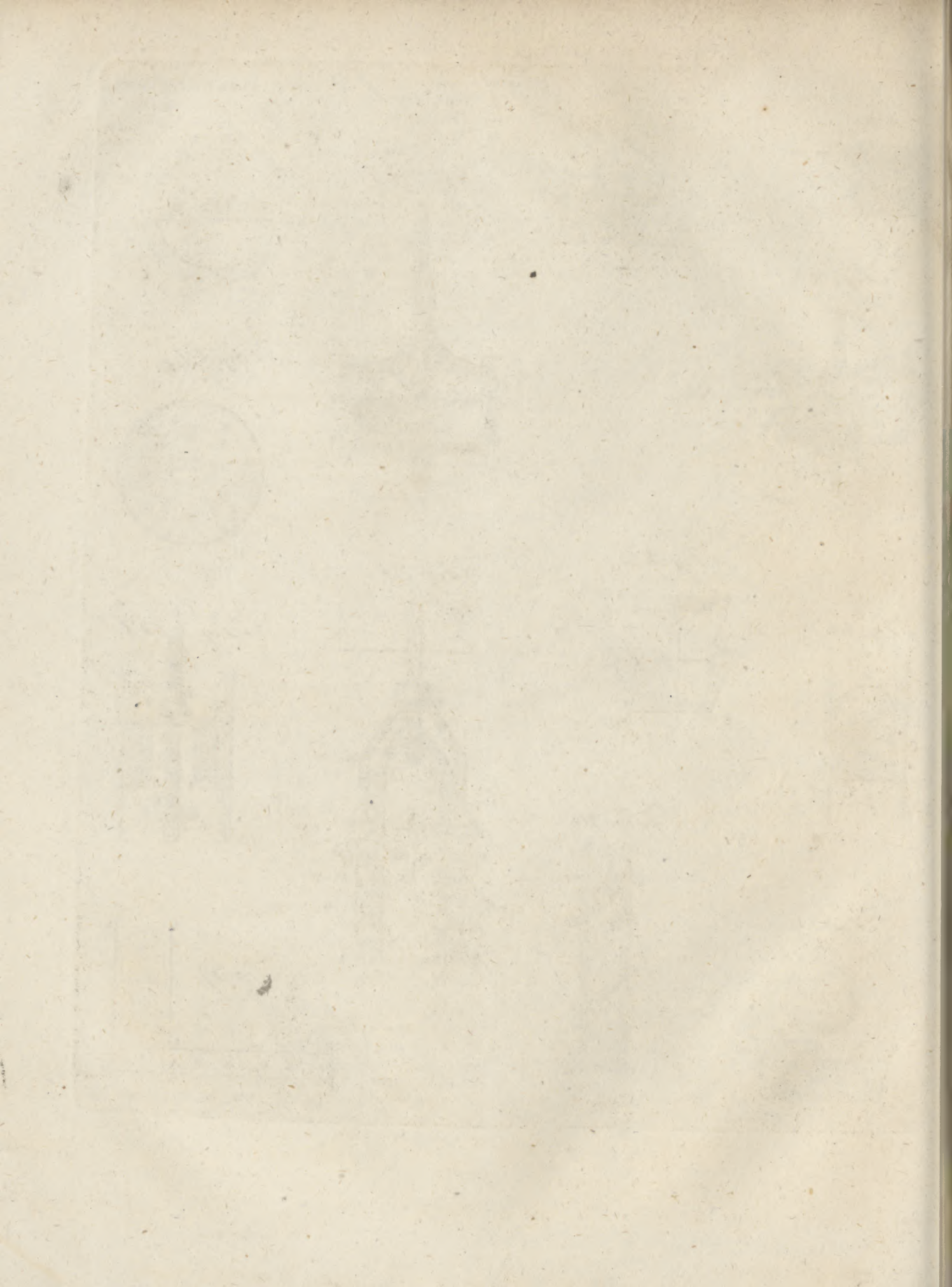


Fig. 37.



J. Hall, Pica, H. C. Schuyler, fecit.



Purgative, same time brings some of his neighbours to make oath that they believe he swears truly. **Purgatory** was anciently by fire or water, or else by combat, and was practised here till abolished by our canons. See *BATTEL in law*, *ORDEAL*, &c.

PURGATIVE or *PURGING Medicines*, medicaments which evacuate the impurities of the body by stool, called also *cathartics*.

PURGATORY, a place in which the just, who depart out of this life, are supposed to expiate certain offences which do not merit eternal damnation. Broughton has endeavoured to prove, that this notion has been held by Pagans, Jews, and Mahometans, as well as by Christians; and that in the days of the Maccabees the Jews believed that sin might be expiated by sacrifice after the death of the sinner, cannot be questioned.

*Papist mis-
represented
and repre-
sented.*

Much abuse has been poured upon the church of Rome for her doctrine of purgatory, and many false representations have been made of the doctrine itself. The following view of it is taken from a work which is considered as a standard by the British Catholics. 1. Every sin, how slight soever, though no more than an idle word, as it is an offence to God, deserves punishment from him, and will be punished by him hereafter, if not cancelled by repentance here. 2. Such small sins do not deserve eternal punishment. 3. Few depart this life so pure as to be totally exempt from spots of this nature, and from every kind of debt due to God's justice. 4. Therefore few will escape without suffering something from his justice for such debts as they have carried with them out of this world; according to that rule of divine justice, by which he treats every soul hereafter according to its works, and according to the state in which he finds it in death. From these propositions, which the Papist considers as so many self-evident truths, he infers that there must be some third place of punishment; for, since the infinite goodness of God can admit nothing into heaven which is not clean and pure from all sin both great and small; and his infinite justice can permit none to receive the reward of bliss, who as yet are not out of debt, but have something in justice to suffer; there must of necessity be some place or state, where souls, departing this life, pardoned as to the eternal guilt or pain, yet obnoxious to some temporal penalty, or with the guilt of some venial faults, are purged and purified before their admittance into heaven. And this is what he is taught concerning purgatory. Which, though he knows not where it is, of what nature the pains are, or how long each soul is detained there; yet he believes, that those that are in this place, being the living members of Jesus Christ, are relieved by the prayers of their fellow members here on earth, as also by alms and masses offered up to God for their souls. And as for such as have no relations or friends to pray for them, or give alms, or procure masses for their relief; they are not neglected by the church, which makes a general commemoration of all the faithful departed in every mass, and in every one of the canonical hours of the divine office.

Such is the Popish doctrine of purgatory, which is built chiefly upon 2 Macc. xii. 43, 44, 45; St Matth. xii. 31, 32; and 1 Cor. iii. 15. By Protestants the books of Maccabees are not acknowledged to be inspired scripture; but if they were, the texts referred to would rather prove that there is no such place as purgatory, since Judas did not expect the souls departed to

Vol. XV. Part II.

reap any benefit from his sin-offering till the resurrection. Our Saviour, in St Luke, speaks of remission in *this world* and in the world to come; but surely neither of these is purgatory. The world to come is the state after the resurrection, and the remission spoken of is the sentence of absolution to be pronounced on the penitent from the seat of general judgment. In the obscure verse referred to in the epistle to the Corinthians, the apostle is, by the best interpreters, thought to speak of the difficulty with which Christians should be saved from the destruction of Jerusalem. Of the state of souls departed he cannot well be supposed to speak, as upon disembodied spirits fire could make no impression. We cannot help, therefore, thinking with the church of England, that "the Romish doctrine of purgatory is a fond thing, vainly invented, and grounded on no warranty of scripture;" but we must confess at the same time, that it appears to us to be a very harmless error, neither hostile to virtue nor dangerous to society. See *RESURRECTION*.

Purification
||
Purific.

PURIFICATION, in matters of religion, a ceremony which consists in cleansing any thing from a supposed pollution or defilement.

The Pagans, before they sacrificed, usually bathed or washed themselves in water; and they were particularly careful to wash their hands, because with these they were to touch the victims consecrated to the gods. It was also customary to wash the vessel with which they made their libations. The Mahometans also use purifications previous to the duty of prayer; which are also of two kinds, either bathing, or only washing the face, hands, and feet. The first is required only in extraordinary cases, as after having lain with a woman, touched a dead body, &c. But lest so necessary a preparation for their devotions should be omitted, either where water cannot be had, or when it may be of prejudice to a person's health, they are allowed in such cases to make use of fine sand, or dust instead of it; and then they perform this duty by clapping their open hands on the sand, and passing them over the parts, in the same manner as if they were dipped in water.

There were also many legal purifications among the Hebrews. When a woman was brought to bed of a male child, she was esteemed impure for 40 days; and when of a female, for 60: at the end of which time she carried a lamb to the door of the temple to be offered for a burnt-offering, and a young pigeon or turtle for a sin-offering; and by this ceremony she was cleansed or purified.

PURIM, or *The FEAST of LOTS*, a solemn festival of the Jews, instituted in memory of the deliverance they received, by means of Mordecai and Esther, from Haman's wicked attempt to destroy them.

PURITAN, a name formerly given in derision to the dissenters from the church of England, on account of the profession to follow the pure word of God, in opposition to all traditions and human constitutions. It was likewise given in the primitive church to the Novatian schismatics, because they would never admit to communion any one who from dread of death had apostatized from the faith.

PURITY, the freedom of any thing from foreign admixture.

PURITY of Style. See *ORATORY*, p. 411, &c.

PURLIEU, signifies all that ground near any forest, which

Purlins
||
Purulent.

which being made forest by King Henry II. Richard I. and King John, was afterwards by perambulations and grants of Henry III. severed again from the same, and made purlieu; that is to say, pure and free from the laws of the forest.—The word is derived from the French *pur* “pure,” and *lieu* “place.”

PURLINS, in building, those pieces of timber that lie across the rafters on the inside, to keep them from sinking in the middle of their length.

By the act of parliament for rebuilding London, it is provided, that all purlins from 15 feet 6 inches to 18 feet 6 inches long, be in their square 9 inches and 8 inches; and all in length from 18 feet 6 inches to 21 feet 6 inches, be in their square 12 inches and 9 inches.

PURPLE, a colour composed of a mixture of red and blue. See *COLOUR-Making*, n° 29. and *DYING*, n° 92.

PURPURA, in natural history. See *MUREX*: where we have given an account of the Tyrian method of dying purple with a liquid extracted from the fish. It has been affirmed, however, that no such method was ever practised. “At Tyre (says Mr Bruce) I engaged two fishermen, at the expence of their nets, to drag in those places where they said shell-fish might be caught, in hopes to have brought out one of the famous purple-fish. I did not succeed; but in this I was, I believe, as lucky as the old fishers had ever been. The purple fish at Tyre seems to have been only a concealment of their knowledge of cochineal; as, had they depended upon the fish for their dye, if the whole city of Tyre applied to nothing else but fishing, they would not have coloured 20 yards of cloth in a year.”

PURPURE, in heraldry. The colour so called, which signifies *purple*, is in engraving represented by diagonal lines, from the left to the right. See *HERALDRY*, p. 441. and Plate CCXXVII. fig. ii. n° 6.

It may serve to denote an administrator of justice, a lawgiver, or a governor equal to a sovereign: and, according to G. Leigh, if it is compounded with

Or,	} it signifies	Riches.
Arg.		Quietness.
Gul.		Politics.
Az.		Fidelity.
Ver.		Cruelty.
Sab.	}	Sadness.

PURPUREUS. See *CONVOLVULUS*, n° 3.

PURRE, or **PERKIN**. See *HUSBANDRY*, n° 238.

PURSER, an officer aboard a man of war, who receives her victuals from the victualler, sees that it be well stowed, and keeps an account of what he every day delivers to the steward. He also keeps a list of the ship's company, and sets down exactly the day of each man's admission, in order to regulate the quantity of provisions to be delivered out, and that the paymaster or treasurer of the navy may issue out the debursments, and pay off the men, according to his book.

PURSLAIN, in botany. See *PORTULACA*.

PURVIEW, a term used by some lawyers for the body of an act of parliament, or that part which begins with “Be it enacted &c.” as contradistinguished from the preamble.

PURULENT, in medicine, something mixed with, or partaking of, pus or matter.

Pus
||
Putrefaction.

PUS, in medicine, a white or yellowish matter designed by nature for the healing and cementing of wounds and sores.

The origin and formation of pus is as much unknown as that of any other animal fluid. In an inaugural dissertation published at Edinburgh by Dr Hendy, the author supposes pus to be a secreted fluid. It has been thought by many, that pus is either a sediment from serum when beginning to putrefy, or that it is the same fluid inspissated by the heat of the body. But both these opinions are refuted by some experiments of our author, which show, that pus is much less inclined to putrefaction than serum, and the putrefaction of both is hastened by an addition of some of the red part of the blood. Some other experiments were made in order to try whether pus could be artificially produced. A thin piece of lamb's flesh, applied to an ulcer discharging laudable pus, and covered over with lead, did not assume the appearance of pus, but became fetid, and was much lessened. Serum, in its inflammatory and in its ordinary state, and lymph in different states, were applied to the same ulcer, which still discharged good pus; but none of these were converted into pus; on the contrary, they became very putrid.

In opposition to these arguments of our author, however, it may be alleged, that if pus was a secreted fluid, the vessels by which it was secreted would certainly be visible; but no such thing has ever been observed: on the contrary, it is certain that pus cannot be formed unless the air is excluded from the wound. These disputes, however, are of no great consequence: but in some cases it becomes a matter of real importance to distinguish pus from mucus; as thus we may be enabled to know whether a cough is consumptive, or merely catarrhus. See *MUCUS*. Mr Home, in a dissertation on the properties of pus, in which he avails himself of the experiments of Mr Hunter, as delivered in his *Physiological Lectures* says, “that the characteristic of pus is its being composed of globules; and he thinks that the presence of globules seems to depend upon the pus being in a perfect state. It differs from the blood in the colour of the globules; in their not being soluble in water, which those of the blood are; and from the fluid in which they swim being coagulable by a solution of sal ammoniac, which serum is not.” Respecting the formation of pus, our author adopts the idea suggested by Mr Hunter, that the vessels of the part assume the nature of a gland, and secrete a fluid which becomes pus. Mr Home ascertains, by experiment, that pus, at its formation, is not globular, but a transparent fluid, of a consistence, in some sort, resembling jelly; and that the globules are formed while lying upon the surface of the fore; requiring, in some instances, while the influence of the external air is excluded, fifteen minutes for that purpose.

PUSTULE, a pimple, or small eruption on the skin full of pus; such as the eruptions of the small-pox.

PUTAMINEÆ, (from *putamen* “a shell,”) the name of the 25th order of Linnæus's fragments of a natural method; consisting of a few genera of plants allied in habit, whose fleshy seed-vessels or fruit is frequently covered with a hard woody shell. See *BOTANY*, p. 462.

PUTEOLI, (Livy, Strabo): a town of Campania;

Puteoli
||
Putrefac-
tion.

Swinburne's
Travels in
the Two Si-
cilies.

so called either from its wells, there being many hot and cold springs thereabouts; or from its stench, *putor*, caused by sulphureous exhalations, (Varro, Strabo). It is now called *Puzzuoli*, and is pleasantly and advantageously situated for trade. In a very remote age, the Cumæans made it their arsenal and dockyard; and to this naval establishment gave the sublime appellation of *Dicearchia* or *Just Power*.

The Romans were well aware of the utility of this port, and took great pains to improve its natural advantages. Nothing remains of their works but a line of piers, built to break the force of a rolling sea: they are vulgarly called the *bridge of Caligula*, because that madman is said to have marched in triumph from *Puzzuoli* to *Baia* on a bridge; but his was a bridge of boats.

The ruins of its ancient edifices are widely spread along the adjacent hills and shores. An amphitheatre still exists entire in most of its parts, and the temple of *Serapis* offers many curious subjects of observation; half of its buildings are still buried under the earth thrown upon it by volcanical commotions, or accumulated by the crumbings of the hill; the inclosure is square, environed with buildings for priests and baths for votaries; in the centre remains a circular platform, with four flights of steps up to it, vases for fire, a central altar, rings for victims, and other appendages of sacrifice, entire and not displaced; but the columns that held its roof have been removed to the new palace of *Caserta* (see *CASERTA*). Behind this round place of worship stand three pillars without capitals, part of the pronaos of a large temple; they are of cipolline marble, and at the middle of their height are full of holes eaten in them by the file-fish *.

The present city contains near 10,000 inhabitants, and occupies a small peninsula; the cathedral was a pagan temple, dedicated to the divinities that presided over commerce and navigation. E. Long. 14. 40. N. Lat. 41. 15.

In the neighbourhood of *Puteoli* are many relics of antient grandeur, of which none deserves more attention than the Campanian way paved with lava, and lined on each side with venerable towers, the repositories of the dead, which are richly adorned with stucco in the inside. This road was made in a most solid expensive manner by order of *Domitian*, and is frequently the subject of encomium in the poems of *Statius*.

PUTI CARAJA, in botany, is a genus of Indian plants, of which the characters, as given by Sir William Jones in the *Asiatic Researches*, vol. ii. p. 351. are these. The calyx is five-cleft, the corolla has five equal petals, the pericarpium a thorny legumen and two seeds, the leaves oval and pinnated, and the stem armed. "The seeds (says the learned President) are very bitter, and perhaps tonic; since one of them, bruised and given in two dozes, will, as the Hindoos assert, cure an intermittent fever."

PUTORIUS, in zoology. See *MUSTELA*.

PUTREFACTION, one of the natural processes, directly opposite to the life of animals and vegetables, by which organized bodies are dissolved, and reduced to what may be called their *original elements*.

Putrefaction differs from chemical solution; because, in the latter, the dissolved bodies are kept in their state of solution by being combined with a certain agent from which they cannot easily be separated; but in pu-

trifaction, the agent which dissolves the body appears not to combine with it in any manner of way, but merely to separate the parts from each other.—It differs also from the resolution of bodies by distillation with violent fire; because, in distillation new and permanent compounds are formed, but by putrefaction every thing seems to be resolved into substances much more simple and indestructible than those which are the result of any chemical process.

The bodies most liable to putrefaction are those of animals and vegetables, especially when full of juices. Stones, though by the action of the weather they will moulder into dust, yet seem not to be subject to any thing like a real putrefaction, as they are not resolved into any other substance than sand, or small dust, which still preserves its lapideous nature. In like manner, vegetables of any kind, when deprived of their juices by drying, may be preserved for many ages without being subjected to any thing like a putrefactive process. The same holds good with respect to animals; the parts of which, by simple drying, may be preserved in a sound state for a much longer time than they could be without the previous exhalation of their juices.

Putrefaction is generally allowed to be a kind of fermentation, or rather to be the last stage of that process; which, beginning with the vinous fermentation, goes on through the acetous, to the stage of putridity, where it stops. It is argued, however, and seemingly not without a great deal of reason, that if putrefaction is a fermentation, it must necessarily be a kind distinct from either the vinous or acetous; since we frequently observe that it takes place where neither the vinous nor the acetous stages have gone before; of consequence, it must be, in some cases at least, entirely independent of and unconnected with them. In several other respects it differs so much from these processes, that it seems in some degree doubtful whether it can with propriety be called a fermentation or not. Both the vinous and acetous fermentations are attended with a considerable degree of heat: but in the putrefaction of animal matters especially, the heat is for the most part so small, that we cannot be certain whether there is any degree of it or not produced by the process. In cases, indeed, where the quantity of corrupting animal matter is very great, some heat may be perceived: and accordingly Dr *Monro* tells us, that he was sensible of heat on thrusting his hand into the flesh of a dead and corrupting whale. But the most remarkable difference between the putrefactive fermentation and that of the vinous and acetous kinds is, that the end of both these processes is to produce a new and permanent compound; but that of the putrefactive process is not to produce any new form, but to destroy, and resolve one which already exists into the original principles from which all things seem to proceed. Thus, the vinous fermentation produces ardent spirits; the acetous, vinegar: but putrefaction produces nothing but earth, and some effluvia, which, though most disagreeable, and even poisonous to the human body, yet, being imbibed by the earth and vegetable creation, give life to a new race of beings. It is commonly supposed, indeed, that volatile alkali is a production of the putrefactive process: but this seems liable to dispute. The vapour of pure volatile alkali is not hurtful to the human frame, but that of putrefying substances is exceedingly so; and, excepting in the case of urine, the generation

Putrefac-
tion.

* *Pholas
Dactylus*,
Linn.

Putrefac-
tion.

generation of volatile alkali in putrid substances is very equivocal. This substance, which produces more alkali than any other, is much less offensive by its putrid fetor than others; and all animal substances produce a volatile alkali on being exposed to the action of fire, of quicklime, or of alkaline salts. In these cases the volatile alkali is not supposed to be produced by the quicklime or fixed salt, but only to be extricated from a kind of ammoniacal salt pre-existing in the animal matters; the probability is the same in the other case, viz. that volatile alkali is not produced, but only extricated, from these substances by putrefaction.

The only thing in which the putrefactive fermentation agrees with the other kinds is, that in all the three there is an extrication of fixed air. In the putrefactive process, it has been thought that this escape of the fixed air deprives the body of its cohesion: and Dr Macbride has written a treatise, in which he endeavours to prove, that fixed air is the very power of cohesion itself, and that all bodies when deprived of their fixed air entirely lose their cohesion. According to this hypothesis, the cause of putrefaction is the escape of fixed air: but it is impossible to give a reason why fixed air, after having so long remained in a body, and preserved its cohesion, should of a sudden begin to fly off without being acted upon by something else. To a similar objection the hypothesis of those is liable, who suppose putrefaction to be occasioned by the escape of phlogiston; for phlogiston is now known to be a chimera: and though it were a reality, it would not fly off without something to carry it off, any more than fixed air. Animalcules have been thought to be the cause of putrefaction: but if animal substances are covered so as to exclude the access of flies or other insects, no such animalcules are to be discovered though putrefaction has taken place; and indeed it requires little proof to convince us, that animals are produced in corrupted bodies only because such substances prove a proper nidus for the eggs of the parent insects.

To understand the true cause of putrefaction, we must take notice of the circumstances in which the process goes on most rapidly. These are, heat, a little moisture, and confined air. Extreme cold prevents putrefaction, as well as perfect dryness; and a free circulation of air carries off the putrid effluvia; a stagnation of which seems to be necessary for carrying on the process. It seems also to hold pretty generally, that putrefying bodies swell and become specifically lighter; for which reason the carcases of dead animals, after having sunk in water, rise to the top and float. This last phenomenon, as has been observed under the article BLOOD, n° 29. shows that these bodies have received a certain quantity of an elastic principle from the air, which thus swells them up to such a size. It may be said indeed, that this increase of size in putrefying bodies is owing only to the extrication of air within themselves: but this amounts to the same thing; for the air which exists internally in the body of any animal, is entirely divested of elasticity while it remains there, and only shows its elastic properties upon being extricated. The elastic principle which combines with the air fixed in the animal substance, therefore, must come from the external atmosphere; and consequently the agent in putrefaction must be the elastic principle of the atmosphere itself, probably the same with elementary fire.

Putrefac-
tion.

But, granting this to be true, it is difficult to show why putrefaction should not take place in a living body as well as in a dead one; seeing the one is as much exposed to the action of the air as the other. This difficulty, however, is not peculiar to the present hypothesis; but will equally occur whatever we may suppose the cause of putrefaction to be. The difficulty seems to be a little cleared up by Dr Priestley, who shows, that, by means of respiration, the body is freed from many noxious effluvia which would undoubtedly destroy it; and by the retention of which, he thinks, a living body would putrefy as soon as a dead one. The way in which respiration prevents the putrefaction of the body, is evidently the same with that in which the wind prevents fish or flesh hung up in it from becoming putrid. The constant inspiration of the air is like a stream of that element continually blown upon the body, and that not only upon its surface, but into it; by which means putrefaction is prevented in those parts that are most liable to become putrid. On the other hand, the elastic principle received from the air by the blood*, * See Blood, n° 29. by invigorating the powers of life, quickening the circulation, and increasing perspiration, enables the body to expel noxious particles from other parts of the body which cannot conveniently be expelled by the lungs.

This leads us to consider the reason why a free exposure to the air prevents the coming on of putrefaction, or why the confining of the putrid effluvia should be so necessary to this process. Here it will be proper to recollect, that putrefaction is a simple resolution of the body into earth, air, &c. of which it seems originally to have been composed. This resolution is evidently performed by an expansive power seemingly situated in every particle of the body. In consequence of this principle, the body first swells, then bursts, flies off in vapour, and its particles fall asunder from each other. The action of the putrefactive process, then, is analogous to that of fire, since these are the very properties of fire, and the very effects which follow the action of fire upon any combustible body. It is therefore exceedingly probable, that the agent in the air, which we have all along considered as the cause of putrefaction, is no other than fire itself; that is, the ethereal fluid expanding itself everywhere, as from a centre to a circumference. The force of the fluid, indeed, is much less in putrefaction than in actual ignition; and therefore the effects also take place in a much smaller degree, and require a much longer time: nevertheless, the same circumstances that are necessary for keeping up the action of fire, are also necessary for keeping up the putrefactive process. One of these is a free access of air, yet without too violent a blast; for as fire cannot burn without air, neither can it endure too much of it: thus a candle goes out if put under a receiver, and the air exhausted; and it will do the same if we blow violently upon it. In like manner, putrefaction requires a certain quantity of air, much less indeed than fire: and as it requires less to support it, so it can also endure much less air than fire; for a stream of air which would not put out a fire, will effectually prevent putrefaction. The cause of this in both is the same. Fire cannot burn because the vapour is carried off too fast; and thus the latent heat, which ought to support the flame §, is entirely dissipated. In § See the like manner putrefaction is as certainly attended with article Flame.

Putrefac-
tion‡ See *Phlo-
giston*.‡ See *Eva-
poration*,
p^o 3.Putrefac-
tion

an emission of azotic gas as fire is with an emission of flame. These gases contain a great quantity of latent heat ‡, or of the expansive principle already mentioned; and if these are carried off with greater rapidity than the heat of the atmosphere can produce them, the consequence must be, that an opposite principle to that which produces putrefaction, namely, a principle of cold, or condensation, instead of expansion, must take place, and the body cannot putrefy. That this must be the case, is evident from the property which all evaporations have of producing cold ‖; and it is well known that a brisk current of air promotes evaporation to a great degree. Hence also the reason is evident why bodies are preserved uncorrupted by cold; for thus the action of the expansive principle is totally overcome and suspended, so that none of its effects can be perceived.

Thus we may see, that one reason why an animal body does not putrefy while alive, is its ventilation, as we may call it, by respiration; and another is, the continual accession of new particles, less disposed to putrefy than itself, by the food and drink which is constantly taken in. But if either of these ways of preventing the commencement of this process are omitted, then putrefaction will take place as well in a living as in a dead body. Of the truth of this last fact we have innumerable instances. When air is infected with the putrid effluvia of marshes, and thus the natural effluvia are not carried off from the human body, but, on the contrary, some enter into it which are not natural to it, the most putrid diseases are produced. The same thing happens from the putrid effluvia of dead bodies. Of this we have a remarkable instance in the fever which took place in Germany in the war of 1755: one reason of which is said to have been an infection of the air by the vast numbers of people killed in battle, to which was added a calm in the atmosphere for a long time; the putrid effluvia being by this prevented from flying off*. When Mr Holwell with 145 others were

* See *Me-
dicine*, p^o
267.

imprisoned in the black-hole at Calcutta, after passing a night in that dismal habitation, he found himself in a high putrid fever. When sailors in long voyages are obliged to feed upon putrid aliments; when, thro' stormy weather, they are much exposed to wet; in the one case the putrescent effluvia being kept from flying off, and in the other a greater quantity being thrown into the body than what it naturally contains, the scurvy, malignant fevers, &c. make their appearance (A). Neither can these diseases be removed without removing every one of the causes just now mentioned: for as putrid diseases will be the consequence of confined air, nastiness, &c. though the provisions be ever so good; so, on the other hand, if the provisions be bad, the best air, and most exact cleanliness, nay, the best medicines in the world, will be of no service; as hath been often observed in the scurvy.

From this account of the nature, cause, and method of preventing putrefaction by means of a current of air, we may easily see the reason why it does not take place in some other cases also. Bodies will not putrefy *in vacuo*, because there the atmosphere has not access to impart its elastic principle; and though in the vacuum itself the principle we speak of does undoubtedly exist, yet its action there is by far too weak to decompose the structure of an animal body. In extreme cold, the reason why putrefaction does not take place has been already shown. If the heat is extremely great, the process of ignition or burning takes place instead of putrefaction. If the body is very dry, putrefaction cannot take place, because the texture is too firm to be decomposed by the weak action of the elastic principle. Putrefaction may also be prevented by the addition of certain substances; but they are all of them such as either harden the texture of the body, and thus render it proof against the action of the elastic fluid, or, by dissolving its texture entirely, bring it into a state similar to what it would be brought by

(A) This aeriform fluid, which is exhaled from animal bodies in a state of putrefaction, acts at certain times more powerfully than at others, and is indeed in one stage of the process infinitely more noxious than any other elastic fluid yet discovered. In the Gentleman's Magazine for August 1788, Dr St John, informs us, that he knew a gentleman who, by slightly touching the intestines of a human body beginning to liberate this corrosive gas, was affected with a violent inflammation, which in a very short space of time extended up almost the entire length of his arm, producing an extensive ulcer of the most foul and frightful appearance, which continued for several months, and reduced him to a miserable state of emaciation. The same writer mentions a celebrated professor who was attacked with a violent inflammation of the nerves and fauces, from which he with difficulty recovered, merely by stooping for an instant over a body which was beginning to give forth this deleterious fluid. Hence he infers, that the same gas modified or mixed, or united with others, may be the occasion of the plague, which has so often threatened to annihilate the human species. It is happy, however, for mankind that this particular stage of putrefaction continues but for a few hours; and, what may appear very remarkable, this destructive gas is not very disagreeable in smell, and has nothing of that abominable and loathsome fetor produced by dead bodies in a less dangerous state of corruption; but has a certain smell totally peculiar to itself, by which it may be instantly discovered by any one that ever smelled it before. This is an object very worthy the attention of physicians: it is both extremely interesting, and very little known; but at the same time it is a study in the highest degree unpleasant, from the detestable smell and nastiness which attend the putrefaction of animal bodies; and a man must be armed with uncommon philanthropy and resolution to attempt it.

Dr St John thinks it probable that there is a rapid fixation of the basis of vital air in dead bodies at a certain state of putrefaction, on account of the luminous appearance which they sometimes make, and which exists but for a few hours: but whether this luminous appearance takes place in every body, or whether it precedes or follows the exhalations of the corrosive gas above-mentioned, he had not, when he wrote his paper, been able to discover.

Putrefac-
tion.

by the utmost power of putrefaction, so that the process cannot then take place. Thus various kinds of salts and acids harden the texture of animal substances, and thus are successfully used as antiseptics. The same thing may be said of ardent spirits; while oils and gums of various kinds prove antiseptic by a total exclusion of air, which is necessary in some degree for carrying on the process of putrefaction. Many vegetables, by the astringent qualities they possess, harden the texture of animal substances, and thus prove powerfully antiseptic; while, on the other hand, fixed alkaline salts, quicklime, and caustic volatile alkali, though they prevent putrefaction, yet they do it by dissolving the substances in such a manner that putrefaction could do no more though it had exerted its utmost force. There is only one other antiseptic substance whose effects deserve to be considered, and that is sugar. This, tho' neither acid nor alkaline, is yet one of the most effectual means of preventing putrefaction: and this seems to be owing to its great tendency to run into the vinous fermentation, which is totally inconsistent with that of putrefaction; and this tendency is so great, that it can scarce be counteracted by the tendency of animal substances to putrefy in any circumstances whatever.

Some kinds of air are remarkably antiseptic, though this subject has not been so fully inquired into as could be wished. The most powerful of them in this respect is the nitrous air; next to it, is fixed air; but the powers of the other airs are not so well known. It is probable that the antiseptic properties of fixed and nitrous air, are owing to their quality of extinguishing fire, or at least that the principle is the same; but, till the nature of these two kinds of air are better known, little can be said with certainty on the subject.

Sir John Pringle has made experiments to determine the powers of certain substances to promote or to prevent putrefaction. From these experiments he has formed the following Table, showing the relative antiseptic powers of the saline substances mentioned. Having found that two drams of beef put in a phial with two ounces of water, and placed in a heat equal to 90° of Fahrenheit's thermometer, became putrid in 14 hours, and that 60 grains of sea-salt preserved a similar mixture of beef and water more than 30 hours, he made the antiseptic power of the sea-salt a standard, to which he compared the powers of the other salts. The algebraic character + signifies, that the substance to which it is annexed had a greater antiseptic power than is expressed by the numbers:

Sea-salt, or the standard	-	-	1
Sal-gem	-	-	1+
Vitriolated tartar	-	-	2
Spiritus Mindereri	-	-	2
Soluble tartar	-	-	2
Sal diureticus	-	-	2+
Crude sal ammoniac	-	-	3
Saline mixture	-	-	3
Nitre	-	-	4+
Salt of hartshorn	-	-	4+
Salt of wormwood	-	-	4+
Borax	-	-	12
Salt of amber	-	-	20
Alum	-	-	30

N. B. The quantities of spiritus Mindereri and of

the saline mixture were such, that each of them contained as much alkaline salt as the other neutral salts.

Myrrh, aloes, asafœtida, and terra Japonica, were found to have an antiseptic power 30 times greater than the standard. Gum ammoniacum and sagapenum showed little antiseptic power.

Of all resinous substances, camphor was found to resist putrefaction most powerfully. Sir John Pringle believes that its antiseptic power is 300 times greater than that of sea-salt.

Chamomile flowers, Virginian snake-root, pepper, ginger, saffron, contrayerva root, and galls, were found to be 12 times more antiseptic than sea-salt.

Infusions of large quantities of mint, angelica, ground-ivy, green tea, red-roses, common wormwood, mustard, and horse-radish, and also decoctions of poppy-heads, were more antiseptic than sea-salt.

Decoctions of wheat, barley, and other farinaceous grains, checked the putrefaction by becoming sour.

Chalk, and other absorbent powders, accelerated the putrefaction, and resolved meat into a perfect mucus. The same powders prevented an infusion of farinaceous grains from becoming mucilaginous and sour.

One dram of sea-salt was found to preserve two drams of fresh beef in two ounces of water, above 30 hours, uncorrupted, in a heat equal to that of the human body, or above 20 hours longer than meat is preserved in water without salt: but half a dram of salt did not preserve it more than two hours longer than pure water. Twenty-five grains of salt had little or no antiseptic quality. Twenty grains, 15 grains, but especially 10 grains only of sea-salt, were found to accelerate and heighten the putrefaction of two drams of flesh.—These small quantities of sea-salt did also soften the flesh more than pure water.

The same learned and ingenious physician made experiments to discover the effects of mixing vegetable with animal matters.

Two drams of raw beef, as much bread, and an ounce of water, being beat to the consistence of pap, and exposed to 90° of heat according to Fahrenheit's thermometer, began to ferment in a few hours, and continued in fermentation during two days. When it began to ferment and swell, the putrefaction had begun; and in a few hours afterwards, the smell was offensive. Next day the putrid smell ceased, and an acid taste and smell succeeded. Fresh alimentary vegetables, as spinach, asparagus, scurvy-grass, produced similar effects as bread on flesh, but in a weaker degree. From several other experiments he found, that animal substances excite the fermentation of vegetable substances, and that the latter substances correct the putrescency of the former.

By adding saliva to a similar mixture of flesh, bread, and water, the fermentation was retarded, moderated, but rendered of twice the usual duration, and the acid produced at last was weaker than when no saliva was used.

By adding an oily substance to the common mixture of flesh, bread, and water, a stronger fermentation was produced, which could not be moderated by the quantity of saliva used in the former experiment, till some fixed alkaline salt was added; which salt was found, without saliva, to stop suddenly very high fermentations.

He did not find that small quantities of the following salts,

Putrefac-
tion.

Putrefac-
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Puzzulana.

salts, sal ammoniac, nitre, vitriolated tartar, sal diureticus, salt of hartshorn, salt of wormwood, were septic, as small quantities of sea-salt were.

Sugar was found to resist putrefaction at first, as other salts do, and also to check the putrefaction after it had begun by its own fermentative quality, like bread and other fermentative vegetables.

Lime-water made some small resistance to putrefaction.

Port-wine, small-beer, infusions of bitter vegetables, of bark, and the juice of antiscorbutic plants, retarded the fermentation of mixtures of flesh and bread. But an unstrained decoction of bark considerably increased that fermentation.

Crabs-eyes accelerated and increased the fermentation of a mixture of flesh and bread.

Lime-water neither retarded nor hastened the fermentation of such a mixture: but when the fermentation ceased, the liquor was neither putrid nor acid, but finelt agreeably.

Flesh pounded in a mortar was found to ferment sooner than that which had not been bruised.

The tough inflammatory crust of blood was found to be most putrescent; next to which the crassamentum, or red coagulated mass; and lastly the serum.

Dr Macbride's experiments confirm many of those above related, especially those which show that the fermentation of vegetable substances is increased by a mixture of animal or putrescent matter; that the putrescency of the latter is corrected by the fermentative quality of the former; and that the putrefaction and fermentation of mixtures of animal and vegetable substances were accelerated by additions of absorbent earths and of Peruvian bark. He also found, that although unburnt calcareous earths were septic, quicklime and lime-water prevented putrefaction, but that they destroyed or dissolved the texture of flesh.

The experiments of the author of the *Essai pour servir à l'Histoire de la Putrefaction*, show that metallic salts, resinous powders, extracts of bark, and opium, are very powerfully antiseptic, and that salts with earthy bases are less antiseptic than any other salts.

PUTTOCK-SHROUDS. See *Puttock-Shrouds*.

PUTTY, in its popular sense, is a kind of paste compounded of whiting and linseed oil, beaten together to the consistence of a thick dough.

It is used by glaziers for the fastening in the squares of glass in sash-windows, and by painters for stopping up the crevices and clefts in timber and wainscots, &c.

PUTTY sometimes also denotes the powder of calcined tin, used in polishing and giving the last gloss to works of iron and steel.

TERRA PUZZULANA, or POZZOLANA, is a greyish kind of earth used in Italy for building under water. The best is found about Puteoli, Baiæ, and Cumæ, in the kingdom of Naples, from the first of which places it derives its name. It is a volcanic product, composed of heterogeneous substances, thrown out from the burning mouths of volcanoes in the form of ashes; sometimes in such large quantities, and with so great violence, that whole provinces have been covered with it at a considerable distance. In the year 79 of the common era, the cities of Herculaneum, Pompeia, and Stabia, although at the distance of many miles from Vesuvius, were, nevertheless, buried under

the matters of these dreadful eruptions; as Bergman *Puzzulona* relates in his *Treatise of the Volcanic Products*. This volcanic earth is of a grey, brown, or blackish colour; of a loose, granular, or dusty and rough, porous or spongy texture, resembling a clay hardened by fire, and then reduced to a gross powder. It contains various heterogeneous substances mixed with it. Its specific gravity is from 2500 to 2800; and it is, in some degree, magnetic: it scarcely effervesces with acids, though partially soluble in them. It easily melts *per se*; but its most distinguishing property is, that it hardens very suddenly when mixed with $\frac{1}{4}$ of its weight of lime and water; and forms a cement, which is more durable in water than any other.

According to Bergman's Analysis, 100 parts of it contain from 55 to 60 of siliceous earth, 20 of argillaceous, five or six of calcareous, and from 15 to 20 of iron. Its effects, however, in cement may perhaps depend only on the iron which has been reduced into a particular substance by means of subterraneous fires; evident signs of which are observable in the places where it is obtained. If the slate in Henneberg, or Kennekulle in the province of Westergottland, should happen to get fire, the uppermost stratum, which now consists of a mixture of iron and different kinds of rocks, called *graberg* in the account given of them, they might perhaps be changed partly into slag and partly into *terra puzzulana*.

It is evidently a martial argillaceous marl, that has suffered a moderate heat. Its hardening power arises from the dry state of the half-baked argillaceous particles, which makes them imbibe water very rapidly, and thus accelerates the desiccation of the calcareous part; and also from the quantity and semiplogificated state of the iron contained in it. It is found not only in Italy but in France, in the provinces of Auvergne and Limoges; and also in England and elsewhere.

PUZZUOLI. See *PUTEOLI*.

PYANEPSIA, in antiquity, an Athenian festival celebrated on the seventh day of the month *Pyaneffion*; which, according to the generality of critics, was the same with our September.

Plutarch refers the institution of this feast to Theſeus, who, after the funeral of his father, on this day paid his vows to Apollo, because the youths who returned with him safe from Crete then made their entry into the city. On this occasion, these young men putting all that was left of their provisions into one kettle, feasted together on it, and made great rejoicing. Hence was derived the custom of boiling pulse on this festival. The Athenians likewise carried about an olive branch, bound about with wool, and crowned with all sorts of first-fruits, to signify that scarcity and barrenness were ceased, singing in procession a song. And when the solemnity was over, it was usual to erect the olive-branch before their doors, as a preservative against scarcity and want.

PYCNOSTYLE, in the ancient architecture, is a building where the columns stand very close to each other; only one diameter and a half of the column being allowed for the intercolumniations.

According to Mr Evelyn, the pycnostyle chiefly belonged to the composite order, and was used in the most magnificent buildings; as at present in the peristyle at St Peter's at Rome, which consists of near 300 columns;

||
Pycnostyle.

Pygargus turns; and in such as yet remain of the ancients, among the ruins of Palmyra.

Pylus.

PYGARGUS, in ornithology, a species of *FALCO*.

PYGMALION, in fabulous history, a king of Cyprus, who, being disgusted at the dissolute lives of the women of his island, resolved to live in perpetual celibacy; but making a statue of ivory, he fell so passionately in love with it, that the high festival of Venus being come, he fell down before the altar of that goddess, and besought her to give him a wife like the statue he loved. At his return home, he embraced, as usual, his ivory form, when he perceived that it became sensible by degrees, and was at last a living maid, who found herself in her lover's arms the moment she saw the light. Venus blessed their union; and, at the end of nine months, she was delivered of a boy, who was named *Paphos*.

PYGMY, a person not exceeding a cubit in height. This appellation was given by the ancients to a fabulous nation inhabiting Thrace; who brought forth young at five years of age, and were old at eight: these were famous for the bloody war they waged with the cranes. As to this story, and for the natural history of the true pygmy, see *SIMIA*.

PYKAR, a broker in India, inferior to those called *dallals*, who transacts the business at first hand with the manufacturer, and sometimes carries goods about for sale.

PYKE, a watchman in India, employed as a guard at night. Likewise a footman or runner on business. They are generally armed with a spear.

PYLADES, a son of Strophius, king of Phocis, by one of the sisters of Agamemnon. He was educated together with his cousin Orestes, with whom he formed the most inviolable friendship, and whom he assisted to revenge the murder of Agamemnon, by assassinating Clytemnestra and Ægisthus. He also accompanied him in Taurica Chersonesus; and for his services Orestes rewarded him, by giving him his sister Electra in marriage. Pylades had by her two sons, Medon and Strophius. The friendship of Orestes and Pylades became proverbial.

PYLORUS, in anatomy, the under orifice of the stomach. See *ANATOMY*, n° 91.

PYLUS (anc. geog.), a town of Elis; its ruins to be seen on the road from Olympia to Elis, (Pausanias); situated between the mouths of the Peneus and Sellees, near Mount Scollis, (Strabo.) Built by Pylas of Megara, and destroyed by Hercules, (Pausanias.)—Another Pylus in Triphylia, (Strabo); by which the Alpheus runs, (Pausanias); on the confines of Arcadia, and not in Arcadia itself, (id.)—A third in Messenia, (Strabo, Ptolemy); situated at the foot of Mount Ægaleus on the sea-coast, over-against the island Sphagea or Sphaeteria: built by Pylas, and settled by a colony of Leleges from Megara; but thence expelled by Neleus and the Pelasgi, and therefore called *Nelea*. (Homer.) A sandy territory. The royal residence of Neleus, and of Nestor his son: the more ancient and more excellent Pylus; whence the proverb *Pylus ante Pylum*, (Aristophanes, Plutarch), used when we want to repress the arrogance and pride of any one: said to be afterwards called *Coryphasium*. It made a figure in the Peloponnesian war; for being rebuilt by the Athenians, it proved of great benefit to them for the space of 15

years, and of much annoyance to the Lacedemonians, (Thucydides). All the three *Pyli* were subject to Nestor, (Strabo.)

Pyramid.

PYRAMID, in geometry, a solid standing on a triangular, square, or polygonal basis, and terminating in a point at the top; or, according to Euclid, it is a solid figure, consisting of several triangles, whose bases are all in the same plane, and have one common vertex.

Pyramids are sometimes used to preserve the memory of singular events, and sometimes to transmit to posterity the glory and magnificence of princes. But as they are esteemed a symbol of immortality, they are most commonly used as funeral monuments and temples to the gods. Such is that of Cestius at Rome; the pyramids of Dashur drawn by Pocock; and those other celebrated ones of Egypt, as famous for the enormity of their size as their antiquity. Of these the largest are the pyramids of *Geeza*, so called from a village of that name on the banks of the Nile, distant from them about 11 miles. The three which most attract the attention of travellers stand near one another on the west side of the river, almost opposite to Grand Cairo, and not far from the place where the ancient Memphis stood. They were visited by M. Savary, of whose description of them we shall here give an abstract.

He took his journey in the night-time, in order to get up to the top of the great one by sunrise. Having got within sight of the two great ones, while the full moon shone upon them, he informs us, that they appeared, at the distance of three leagues, like two points of rock crowned by the clouds.

It is in the rich territory which surrounds them that fable has placed the Elysian fields. The canals which intersect them are the Styx and Lethe.

"The aspects of the pyramids varied according to the circuits he made in the plain, and the position of the clouds displayed themselves more and more to view. At half past three in the morning we arrived (says he) at the foot of the greatest. We left our clothes at the gate of the passage which leads to the inside, and descended, carrying each of us a flambeau in his hand. Towards the bottom you must creep like serpents to get into the interior passage, which corresponds with the former. We mounted it on our knees, supporting ourselves with our hands against the sides. Without this precaution one runs the risk of slipping on the inclined plane, where the slight notches are insufficient to stop the foot, and one might fall to the bottom. Towards the middle we fired a pistol, the frightful noise of which, repeated in the cavities of this immense edifice, continued a long time, and awakened thousands of bats, which flying round us, struck against our hands and faces, and extinguished several of our wax candles. They are much larger than the European bats. Arrived above, we entered a great hall, the gate of which is very low. It is an oblong square, wholly composed of granite. Seven enormous stones extend from one wall to the other, and form the roof. A sarcophagus made of a single block of marble lies at one end of it. It is empty; and the lid of it has been wrenched off. Some pieces of earthen vases lie around it. Under this beautiful hall is a chamber not so large, where you find the entrance to a conduit filled with rubbish. After examining these caves, where daylight never penetrated, we descended the same way, taking care not to fall in-

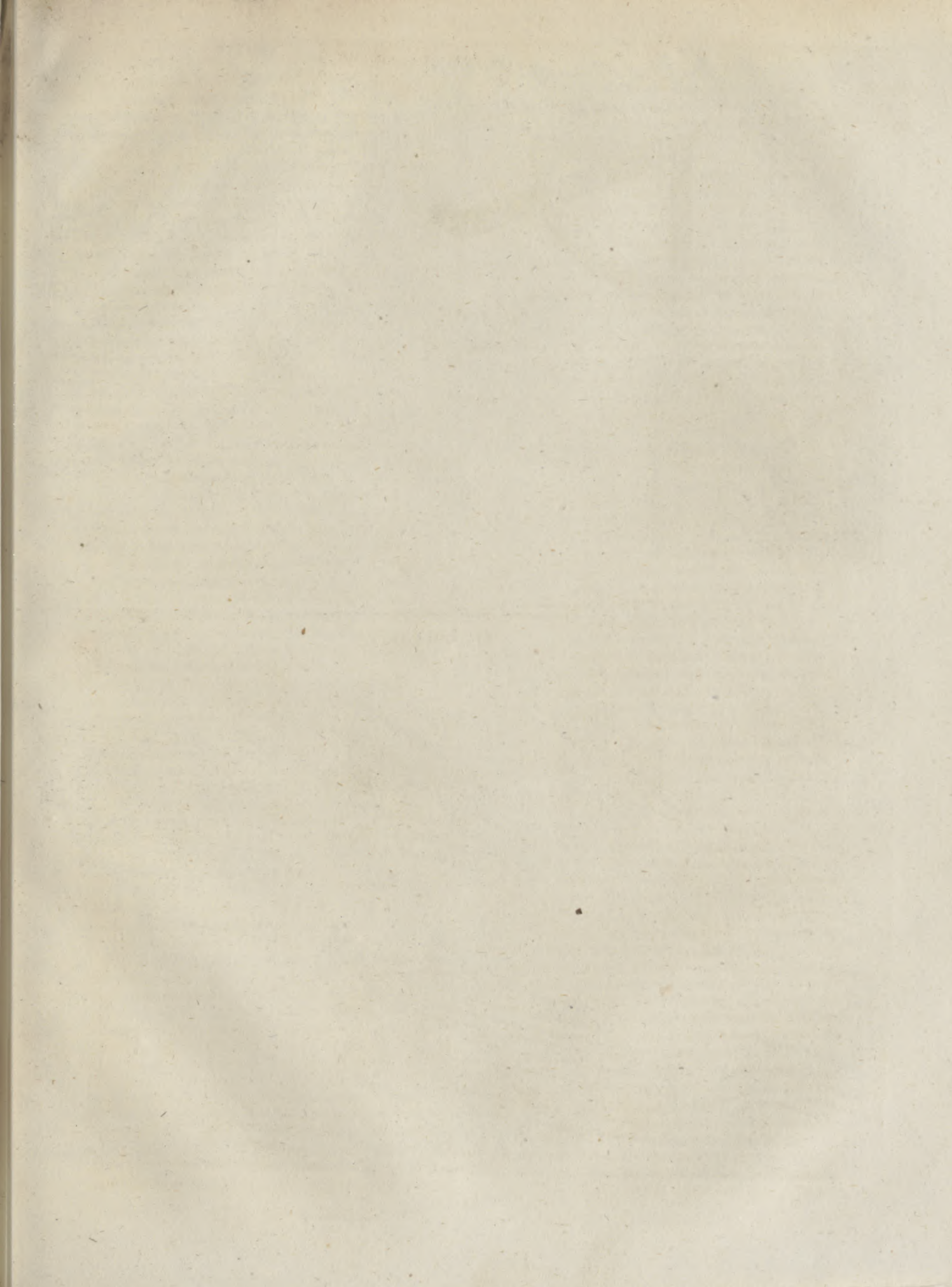


Fig. 6.
Gunnerys Quadrant.



Fig. 1.
Coles Quadrant.

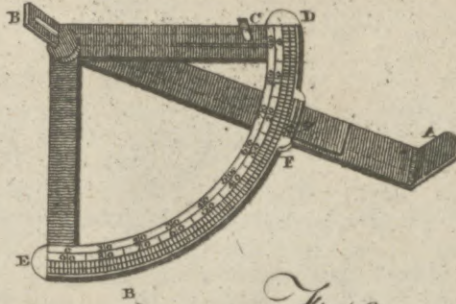


Fig. 4.
Suttons Quadrant.

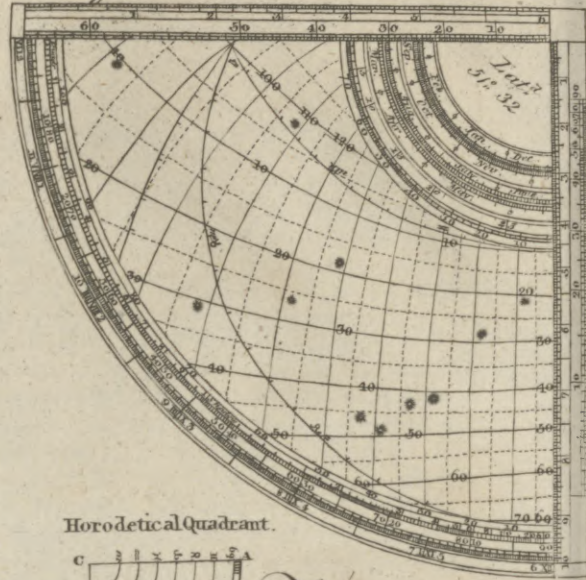


Fig. 5.
Smical Quadrant.

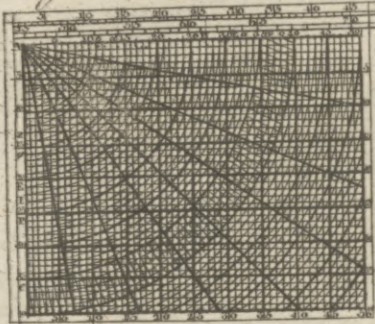
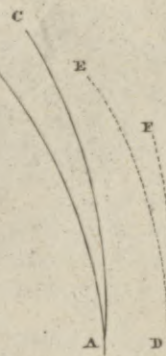


Fig. 2.
Rainbow.



Horodetical Quadrant.

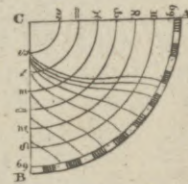
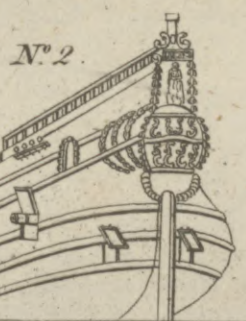
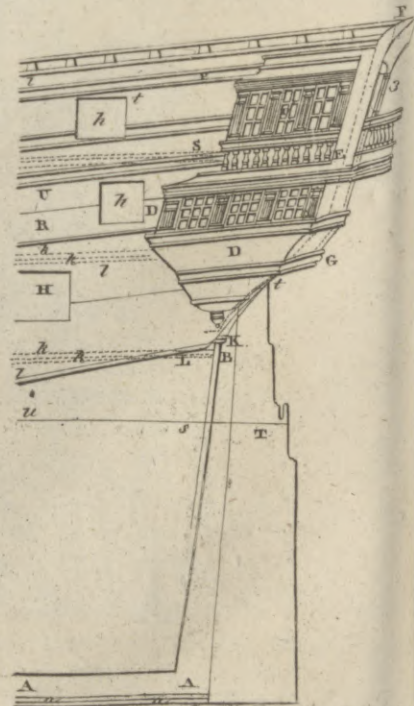


Fig. 3.

QUARTER.



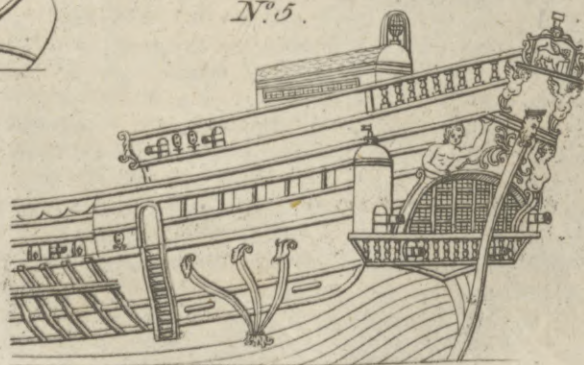
N° 1.



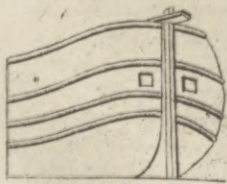
N° 3.



N° 5.



N° 6.



Pyramid. to a well, which is on the left, and goes to the very foundations of the pyramid. Pliny makes mention of this well, and says it is 26 cubits deep. The internal air of this edifice never being renewed, is so hot and mephitic that one is almost suffocated. When we came out of it, we were dropping with sweat, and pale as death. After refreshing ourselves with the external air, we lost no time in ascending the pyramid. It is composed of more than 200 layers of stone. They overlap each other in proportion to their elevation, which is from two to four feet. It is necessary to climb up all these enormous steps to reach the top. We undertook it at the north-east angle, which is the least damaged. It took us, however, half an hour with great pains and many efforts to effect it.

"The sun was rising, and we enjoyed a pure air, with a most delicious coolness. After admiring the prospect around us, and engraving our names on the summit of the pyramid, we descended cautiously, for we had the abyss before us. A piece of stone detaching itself under our feet or hands might have sent us to the bottom.

"Arrived at the foot of the pyramid, we made the tour of it, contemplating it with a sort of horror. When viewed close, it seems to be made of masses of rocks; but at a hundred paces distance, the largeness of the stones is lost in the immensity of the whole, and they appear very small.

"To determine its dimensions is still a problem. From the time of Herodotus to our days it has been measured by a great number of travellers and learned men, and their different calculations, far from clearing up doubts, have only increased the uncertainty. The following table will serve at least to prove how difficult it is to come at the truth.

<i>Height of the great Pyramid.</i>		<i>Width of one of its sides.</i>	
Ancients.		French Feet.	
Herodotus	800	-	800
Strabo	625	-	600
Diodorus Siculus	600 and a fraction.	-	700
Pliny	-	-	708
Moderns.			
Le Bruyn	616	-	704
Prosper Alpinus	625	-	750
Thevenot	520	-	682
Niebuhr	440	-	710
Greaves	444	-	648

Number of layers of Stone which form it.

Greaves	207	-	layers.
Maillet	208	-	
Albert Liewenstein	260	-	
Pococke	212	-	
Belon	250	-	
Thevenot	208	-	

"It appears that Messrs Greaves and Niebuhr have prodigiously deceived themselves in measuring the perpendicular height of the great pyramid. All the travellers allow that it has at least 200 layers of stone. These layers are from two to four feet high. Accord-

Pyramid. ing to Pococke, they are from four feet and a half to four feet high, being not so high at the top as at the base. Prosper Alpinus informs us, that the elevation of the first layer is five feet, but it diminishes insensibly in proportion as one mounts. Thevenot mentions 208 steps of large stones, the thickness of which makes the height of them about two feet and a half one with another: He measured some of them more than three feet high. I have measured several of them which were more than three feet high, and I found none less than two; the least height of them we can take as a medium therefore is two feet and a half, which, even according to Mr Greaves's calculation, who reckons 207 layers, would make 517 feet 6 inches perpendicular height. Messrs Greaves, Maillet, Thevenot, and Pococke, who only differ in the number of the layers from 207 to 212, all mounted by the north-east angle, as the least injured. I followed the same route, and counted only 208 steps. But if we reflect that the pyramid has been open on the side next the desert, that the stones on that side have been thrown down, that the sand which covers them has formed a considerable hill, we shall not be astonished that Albert Liewenstein, Belon, and Prosper Alpinus, who must have mounted by the south-east or south-west angle, which are less exposed to the sands of Lybia, should have found a greater number of steps: so that the calculation of these travellers, agreeing with that of Diodorus Siculus and Strabo, appears to be nearest the true height of the pyramid taken at its natural base; whence we may conclude with reason that it is at least 600 feet high. Indeed this is authenticated by a passage of Strabo. These are his words: 'Towards the middle of the height of one of the sides is a stone that may be raised up. It shuts an oblique passage which leads to a coffin placed in the centre of the pyramid.' This passage, open in our days, and which in the time of Strabo was towards the middle of one face of the pyramid, is at present only 100 feet from the base. So that the ruins of the covering of the pyramid, and of the stones brought from within, buried by the sand, have formed a hill in this place 200 feet high. Pliny confirms this opinion. The great sphynx was in his time upwards of 62 feet above the surface of the ground. Its whole body is at present buried under the sand. Nothing more appears of it than the neck and head, which are 27 feet high. If even the sphynx, though defended by the pyramids against the northerly winds, which bring torrents of sand from Libya, be covered as high as 38 feet, what an immense quantity must have been heaped up to the northward of an edifice whose base is upwards of 700 feet long? It is to this we must attribute the prodigious difference between the accounts of the historians who have measured the great pyramid at distant periods, and at opposite angles. Herodotus, who saw it in the age nearest to its foundation, when its true base was still uncovered, makes it 800 feet square. This opinion appears very probable. Pliny also says that it covered the space of eight acres.

"Messrs Shaw, Thevenot, and the other travellers who pretend that this pyramid was never finished, because it is open and without coating, are in an error. It is only necessary to observe the remains of the mortar, with the splinters of white marble which are to be found in

Pyramid.

many parts of the steps, to see that it has been coated. After reading attentively the description given of it by the ancients, every doubt vanishes, and the truth is as clear as day-light. Herodotus tells us, 'The great pyramid was covered with polished stones, perfectly well jointed, the smallest of which was 30 feet long. It was built in the form of steps, on each of which were placed wooden machines to raise the stones from one to another.' According to Diodorus, 'The great pyramid is built of stones, very difficult of workmanship, but of an eternal duration. It is preserved to our days (towards the middle of the Augustan age) without being in the least injured. The marble was brought from the quarries of Arabia.' This historian thought that the whole building was composed of stones, similar to those of the coating, which were of very hard marble. Had there been some pieces torn off, he would have perceived under that covering a calcareous stone rather soft. Pliny says that it 'is formed of stones brought from the quarries of Arabia. It is not far from the village of Busris (which still exists under the name of *Boufir*), where those persons reside who are so skilful as to climb up to the top.'

"This passage shows that Pliny, deceived by the appearance, was in the same error with Diodorus Siculus. It demonstrates also that it was covered: for what difficulty would there have been for the inhabitants of Busris to scale a building raised by steps? but it was really a prodigy for them to get up it when it formed a mountain, the four inclined planes of which presented a surface covered with polished marble. It is indeed an incontestable fact, that the great pyramid was coated. It is as certain too that it has been shut, as Strabo gives us to understand; and that by removing a stone placed in the middle of one of the sides, one found a passage which led to the tomb of the king. But I shall leave Mr Maillet, who visited it 40 times with all imaginable attention, the honour of relating the means employed to open it. I have examined the inside of it in two different journeys: twice I have mounted it: and I cannot help admiring the sagacity with which that author has developed the mechanism of that astonishing edifice."

Our author next proceeds to give a particular description of the methods by which it is most probable that the pyramids were closed, and the immense labour requisite to open them; but as this description affords nothing very interesting, we shall not insert it. Only we must remark, that the final outlet to the workmen he supposes to have been the well at the entrance formerly mentioned. This well descends towards the bottom of the pyramid by a line not quite perpendicular to the horizon, but slanting a little, in such a manner as to resemble the figure of the Hebrew letter Lamed. About 60 feet from the aperture there is a square window in this passage, from whence we enter a small grotto hewn out of the mountain; which in this place is not a solid stone, but a kind of gravel concreted together. The grotto extends about 15 feet from east to west, where there is another groove hollowed likewise, but almost perpendicular. It is two feet four inches wide by two and an half in height. It descends through a space of 123 feet, after which we meet with nothing but sand and stones. M. Savary is convinced that the only use of this passage was to serve as a retreat for the labourers who constructed the pyramid; and of this he looks

upon the slope of the conduit, its winding road, its smallness, and its depth, to be certain proofs. The way out of it he supposes to have been formed by a passage over which hung a row of stones, which they had discovered the secret of suspending, and which falling down into the passage by the means of some spring they set in motion, shut up the entrance for ever, as soon as the workmen were withdrawn from the pyramid.

It seems to be an unquestionable fact, that this pyramid was a mausoleum of one of the kings of Egypt, and it is very probable that all the rest answered similar purposes. We do not, however, think that this was their primary use or the original design of their builders. Mr Bryant is of opinion that they were temples erected in honour of the Deity; and a very ingenious writer in the Gentleman's Magazine for June 1794 has done much to prove that they were altars dedicated to the sun, the first and greatest god in every pagan calendar.

"Our English word pyramid (says he) is directly derived from the Latin *pyramis*, and mediately from the Greek *πυραμῖς*; all denoting the same mathematical figure. The original of the whole seems to be the Egyptian word *pyramoua*, which, we are told by Oriental scholars, signifies light, or a ray of light. From this Coptic vocable the word *πυρ* in Greek, signifying fire, is probably descended; as the flames of fire assume that conical or pyramidal form which the solar rays commonly display; and as it is natural for the mind to distinguish its objects rather by their external qualities, and those obvious and interesting appearances which they exhibit to the senses, than by their constituent and inseparable properties.

"The ancient Egyptians seem to have penetrated very far into the mysteries of nature; and although their superstition appears at first sight to be extremely gross and absurd, yet it is very probable that their deities were only emblematical personages, representing by sensible images the grand effects or presiding principles which they supposed to exist in the universe. Thus the moon was called *Isis*, and the sun *Osiris*; and to the honour of this last deity, from whose visible influence and creative energy all things seem to spring into existence, it is not improbable that the Egyptians erected those stupendous monuments, and dedicated them to him as temples or altars. It was natural to build them in that shape which the rays of the sun display when discovered to the eye, and which they observed to be the same in terrestrial flame, because this circumstance was combined in their imaginations with the attribute which they adored. If they were temples dedicated to the sun, it seems a natural consequence that they should likewise be places of sepulture for kings and illustrious men, as the space which they covered would be considered as consecrated ground. This hypothesis is common, and is not contradicted by the present reasoning. But, considering them as altars, and as most travellers agree that they were never finished, but terminate in a square horizontal surface, it would not be refining too much to venture an assertion that, in great and solemn acts of adoration, the Egyptians constructed fires, the flames of which should terminate in the vertex of the pyramid, and so complete that emanation of their deity which they admired and adored. As far, therefore, as we are justified in forming any conclusion on so dark a subject,

Pyramid. we may venture to say, that the Egyptian pyramids were temples or altars dedicated to the sun, as the material representative of that invisible power which creates, governs, and pervades, the whole system of nature."

This reasoning has great force; and it certainly receives additional strength from the undoubted fact, that the first statues for idolatrous worship were erected on the tops of mountains, and of a pyramidal or conical form. (See **POLYTHEISM**, n° 13 and 21.) It is likewise corroborated by other circumstances discovered by the members of the Asiatic Society. In the second volume of their transactions we have an account of several large statues of the gods **SEEVA** and **MCHEDO**, all of a conical or pyramidal figure; but it has been shown in the article already referred to, that the idolatry of Hindostan was probably of Egyptian original.

It is not known in Europe when the pyramids were built; but we have reason to expect a history of them soon from Shanferit records examined by Mr Wilford lieutenant of engineers. It is as little known at what time, or from what motive, the great pyramid was opened. Some think it was done by one of the khalifs about the beginning of the eighth century, in expectation of finding a great treasure; but all he met with was the king's body, with some golden idols which had been buried along with it.—By others it is supposed to have been done by the celebrated Harun Al Bafakid khalif of Bagdad; but all are agreed that this pyramid was opened in the time of the Arabs. The second pyramid has likewise been opened; and an attempt was made not long ago upon the third by one of the Beys of Cairo: but after removing a number of stones at a considerable expence, he thought proper to desist from the enterprize.—Mr Bryant is of opinion that the pyramids, at least the three great ones, are not artificial structures of stone and mortar, but solid rocks cut into a pyramidal shape, and afterwards cased with stone; and to this we find that Mr Bruce likewise assents. The reason given for this opinion is, that the passages within it seem rather to answer to the natural cavities and rents in rocks than to the artificial ones in buildings. The opinion, however, we think sufficiently confuted by Savary and Maillet: and, as an acute critic observes, it is in itself as improbable as that the caverns inhabited by the *Troglodytes* were dug by the hands of man. See **TROGLODYTES**.

On the east side of the second pyramid is the sphynx, an enormous mass of one solid stone, but so buried in the sand that only the top of the back is visible, which is 100 feet long. Its head rises, as we have seen, 27 feet above the sand; and its face has been disfigured by the Arabs, who hold all representations of men and living animals in detestation. Other travellers say that this sphynx is a huge misshapen rock, by no means worthy of the attention which has been bestowed upon it.

In the desert of Saccara there are a great number of pyramids, which, in Mr Bruce's opinion, are composed of clay. They terminate in what the inhabitants call a *dagiour*, or *fusse pyramid*, about two miles from the Nile, between Suf and Woodan. This is no other than a hill cut into the shape of a pyramid, or naturally so formed, for a considerable height; on the top of which is a pyramidal building of brick terminating in a point, and having its basis so exactly adapted to the top of the hill, that at a distance the difference cannot be perceived; especially as the face of the stone resembles very

nearly the clay of which the pyramids of the Saccara are composed.

PYRAMIDALES, in anatomy, one of the muscles of the abdomen. See **ANATOMY**, *Table of the Muscles*.

Pyrami-
dales
||
Pyrometer.

PYRENEAN MOUNTAINS, or **PYRENEES**, are the mountains which divide France from Spain, and are the most celebrated in Europe, except the Alps. They reach from the Mediterranean Sea as far as the ocean, and are about 212 miles in length. They have different names, according to the different places wherein they stand. Some think they are as high as the Alps; but the passages over them are not so difficult, whatever some travellers may think who have not crossed the former.

BANKSIA PYRIFORMIS, in botany, is a species of **BANKSIA**, which see. It was unknown to Linnæus; and Gaertner, who has mentioned it, gives no specific character of it. It has solitary flowers, ovate downy capsules, and lance-shaped entire smooth leaves. The capsules larger than in any other known species. See *White's Journal of a Voyage to New South Wales*, p. 221—225.

PYRITES, a genus of inflammable substances composed of sulphur, which has dissolved or saturated itself with metals. Thus there are many kinds of pyrites; as of gold, arsenic, iron, &c. It is also the principal ore of sulphur; particularly that called *martial pyrites*, *copperas-stone*, or *marcasite*. This is very common, containing a quantity of sulphur in proportion to the iron; and, when thoroughly inflamed, burns by itself. It is either of a compact texture, steel-grained, coarse-grained, or crystallised. In this last form, it shoots mostly into cube and octohedral figures, though it is met with also in innumerable other forms.

The liver-coloured marcasite has an appearance between that of the preceding and the blue copper-ore. The iron predominates in this kind, so that it is less fit than the other for extracting sulphur from it, or for the smelting of copper-ores. It is formed of a compact texture, coarse-grained, and steel-grained. See **CHEMISTRY**, n° 619 and 654; **MINERALOGY**, p. 109; and **METALLURGY**, p. 429.

PYRMONT, a town of Lippe in Germany, in the circle of Westphalia, and capital of a country of the same name. It has a castle, kept by a governor, who is under the counts of Waldeck. At a small distance from hence there are mineral waters, which are much esteemed. The Protestants have here the free exercise of their religion. It is seated on the confines of the duchy of Brunswick, 40 miles south-west of Hanover. E. Long. 9. 0. N. Lat. 52. 0.

PYROLA, in botany: A genus of the monogynia order, belonging to the deandria class of plants; and in the natural method ranking under the 18th order, *Bicornes*. The calyx is quinquepartite; there are five petals; the capsule is quinquelocular, opening at the angles.

PYROMANCY, a kind of divination by means of fire. See **DIVINATION**, n° 6.

PYROMETER, an instrument for measuring the expansion of bodies by heat. See **CHEMISTRY**, n° 103. Muschenbroeck, who was the original inventor of this machine, has given a table of the expansion of the different metals in the same degree of heat. Having prepared cylindric rods of iron, steel, copper, brass, tin,

Pyrometer, and lead, he exposed them first to a pyrometer with one flame in the middle; then with two flames; and successively to one with three, four, and five flames. But previous to this trial, he took care to cool them equally, by exposing them some time upon the same stone, when it began to freeze, and Fahrenheit's thermometer was at 32 degrees. The effects of which experiment are digested in the following table, where the degrees of expansion are marked in parts equal to the 1000 part of an inch.

Expansion of	Iron.	Steel.	Copper.	Brass.	Tin.	Lead.
By one flame	80	85	89	110	153	155
By two flames placed close together.	117	123	115	220		274
By two flames $2\frac{1}{2}$ inches distant.	109	94	92	141	219	263
By three flames placed close together.	142	168	193	275		
By four flames placed close together.	211	270	270	361		
By five flames.	230	310	310	377		

It is to be observed of tin, that it will easily melt when heated by two flames placed together. Lead commonly melts with three flames placed together, especially if they burn long.

From these experiments, it appears at first view that iron is the least rarefied of any of these metals, whether it be heated by one or more flames; and therefore is most proper for making machines or instruments which we would have free from any alterations by heat or cold, as the rods of pendulums for clocks, &c. So likewise the measures of yards or feet should be made of iron, that their length may be as nearly as possible the same summer and winter.

The expansion of lead and tin, by only one flame, is nearly the same; that is, almost double of the expansion of iron. It is likewise observable, that the flames placed together, cause a greater rarefaction than when they have a sensible interval between them; iron in the former case, being expanded 117 degrees, and only 109 in the latter; the reason of which difference is obvious.

By comparing the expansions of the same metal produced by one, two, three, or more flames, it appears that two flames do not cause double the expansion of one, nor three flames three times that expansion, but always less; and these expansions differ so much the more from the ratio of the number of flames as there are more flames acting at the same time.

It is also observable, that metals are not expanded equally at the time of their melting, but some more some less. Thus tin began to run when rarefied 219 degrees; whereas brass was expanded 377 degrees, and yet was far from melting.

Mr Ellicot found, upon a medium, that the expansion of bars of different metals, as nearly of the same dimensions as possible, by the same degree of heat, were as follow:

Gold, Silver, Brass, Copper, Iron, Steel, Lead,
73 103 95 89 60 56 149

The great difference between the expansions of iron and brass has been applied with good success to remedy the irregularities in pendulums arising from heat. See PENDULUM.

Mr Graham used to measure the minute alterations, in length, of metal bars, by advancing the point of a micrometer-screw, till it sensibly stopped against the end of the bar to be measured. This screw, being small and very lightly hung, was capable of agreement within the three or four-thousandth part of an inch. On this general principle Mr Smeaton contrived his pyrometer, in which the measures are determined by the contact of a piece of metal with the point of a micrometer-screw.

The following table shows how much a foot in length of each metal grows longer by an increase of heat, corresponding to 180° of Fahrenheit's thermometer, or to the difference between freezing and boiling water, expressed in such parts of which the unit is equal to the 10,000th part of an inch.

1. White-glass barometer tube,	-	100
2. Martial regulus of antimony,	-	130
3. Blistered steel,	-	138
4. Hard steel,	-	147
5. Iron,	-	151
6. Bismuth,	-	167
7. Copper hammered,	-	204
8. Copper eight parts, with tin one,	-	218
9. Cast brass,	-	225
10. Brass sixteen parts, with tin one,	-	229
11. Brass-wire,	-	232
12. Speculum metal,	-	232
13. Spelter folder, viz. brass two parts, zinc one,	-	247
14. Fine pewter,	-	274
15. Grain tin,	-	298
16. Soft folder, viz. lead two, tin one,	-	301
17. Zinc eight parts, with tin one, a little hammered,	-	323
18. Lead,	-	344
19. Zinc or spelter,	-	353
20. Zinc hammered half an inch per foot,	-	373

We shall close this article with a brief description of a pyrometer lately invented by M. De Luc, in consequence of a hint suggested to him by Mr Ramsden. The basis of this instrument is a rectangular piece of deal-board two feet and a half long, 15 inches broad, and one inch and a half thick; and to this all the other parts are fixed. This is mounted in the manner of a table, with four deal legs, each a foot long and an inch and a half square, well fitted near its four angles, and kept together at the other ends by four firm cross-pieces. This small table is suspended by a hook to a stand; the board being in a vertical situation in the direction of its grain, and bearing its legs forward in such a manner as that the cross-pieces which join them may form a frame, placed vertically facing the observer. This frame sustains a microscope, which is firmly fixed in another frame that moves in the former by means of grooves, but with a very considerable degree of tightness;

Pyrometer,
Pyropho-
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Pyropho-
rus.

ness; the friction of which may be increased by the pressure of four screws. The inner sliding frame, which is likewise of deal, keeps the tube of the microscope in a horizontal position, and in great part without the frame, insomuch that the end which carries the lens is but little within the space between the frame and the board. This microscope is constructed in such a manner as that the object observed may be an inch distant from the lens; and it has a wire which is situated in the focus of the glasses, in which the objects appear reversed. At the top of the apparatus there is a piece of deal, an inch and a half thick and two inches broad, laid in a horizontal direction from the board to the top of the frame. To this piece the rods of the different substances, whose expansion by heat is to be measured, are suspended: one end of it slides into a socket, which is cut in the thickness of the board; and the other end, which rests upon the frame, meets there with a screw, which makes the piece move backward and forward, to bring the objects to the focus of the microscope. There is a cork very strongly driven through a hole bored vertically through this piece; and in another vertical hole made through the cork, the rods are fixed at the top; so that they hang only, and their dilatation is not counteracted by any pressure. In order to heat the rods, a cylindrical bottle of thin glass, about 21 inches high, and four inches in diameter, is placed in the inside of the machine, upon a stand independent of the rest of the apparatus. In this bottle the rods are suspended at a little less than an inch distance from one of the insides, in order to have them near the microscope. Into this bottle is poured water of different degrees of heat, which must be stirred about, by moving upwards and downwards, at one of the sides of the bottle, a little piece of wood, fastened horizontally at the end of a stick: in this water is hung a thermometer, the ball of which reaches to the middle of the height of the rods. During these operations the water rises to the cork, which thus determines the length of the heated part; the bottle is covered, to prevent the water from cooling too rapidly at the surface; and a thin case of brass prevents the vapour from fixing upon the piece of deal to which the rods are fixed.

PYROPHORUS, formed of *αργ. fire*, and *φωσφ. I bear*, in chemistry, the name usually given to that substance called by some black phosphorus; a chemical preparation possessing the singular property of kindling spontaneously when exposed to the air. See CHEMISTRY, n° 1414.

This substance was accidentally discovered by M. Homberg, who prepared it of alum and human feces. See PHOSPHORUS. It was apprehended, for a considerable time after the discovery, that human feces were essential to the operation, till the youngest son of the great Lemerî found that honey, sugar, flour, and indeed any animal or vegetable matter, might be substituted instead of the human feces; and since that time, M. De Sauvigny has shown that most vitriolic salts may be substituted for the alum; having added to the aluminous pyrophorus of Homberg two other classes of substances of this kind, viz. the metallic, or those made with the three vitriols of iron, copper, and zinc; and the neutral, or those composed of vitriolated tartar and Glauber's salt.

Mr Bewly prepares his pyrophorus in the following manner. "I fill (says he) half or three-fourths of the bowl of a tobacco-pipe with a mixture, consisting of two parts of alum, previously calcined in a red-heat, and of powdered charcoal and salt of tartar each one part; pressing the matter down slightly, and filling the remainder of the bowl with fine sand. As soon as the powder becomes hot, the sand lying over it is put into a state of ebullition, which generally continues several minutes. This appearance seems to proceed partly from the vitriolic acid in the alum leaving its earth, and expelling fixed air from the alkali; while another part of it is possibly converted into vitriolic acid air. This phenomenon is succeeded by the appearance of a blue sulphureous flame, proceeding from the combination of the same acid with what was formerly called the *phlogiston of the coal*, and which continues about ten minutes or a quarter of an hour. After it ceases, no other remarkable appearance presents itself. The matter is now to be kept in a red heat 20 minutes or half an hour; or it may continue there two hours longer, if the operator pleases, without any injury to the pyrophorus. The pipe being taken out of the fire, the matter is knocked out of it as soon as it becomes cool, and generally pretty soon afterwards takes fire spontaneously."

In another experiment, having added successively various and increasing quantities of fixed alkali to the salt heated as above, till the vitriolic acid contained in the mixture might be considered merely as an evanescent quantity, a pyrophorus was still produced on calcining it with charcoal as before. He also mixed equal parts of salt of tartar and vegetable or animal coal, or sometimes three parts of the former with two of the latter, and calcined them in the usual manner: and this composition, on being exposed to the air, generally kindled in half a minute or a minute; though, as it contained no sulphur, it did not burn with so much vivacity as the vitriolic pyrophori. This, which Mr Bewly calls the *alkaline pyrophorus*, differs in no circumstance from M. De Sauvigny's neutral pyrophori, except in its not containing that principle to which he ascribes their accension. However, lest it might be suspected that the salt of tartar which he employed might accidentally contain vitriolated tartar, or vitriolic acid, he repeated the experiment with tartar calcined by himself, as well as with nitre fixed or alkali fixed by deslagration with charcoal, and with iron filings; and in all these cases with the same result. By diversifying in a like manner M. De Sauvigny's experiments on the metallic pyrophori, Mr Bewly found that none of the three vitriols, heated with charcoal alone, in his usual method, could produce a pyrophorus. And thus he found that the addition of an alkaline salt to the composition, which was a part of M. De Sauvigny's process, was essential to its success.

Treating in the usual manner equal parts of calcined green vitriol and charcoal, the powder, which contained no sulphur nor hepar sulphuris, did not acquire any of the properties of a pyrophorus. The vitriolic acid seemed to have been entirely dissipated, having no base to detain it, when dislodged from the metallic earth. The charcoal and calx of iron left in this process were calcined again, together with some salt of tartar: and a pyrophorus was produced, which exhibited indications of its containing a scarce perceptible portion

Pyropho-
rus.

portion of hepar sulphuris. Thirty grains of crocus martis astringens were calcined with 15 grains of charcoal, and the same quantity of salt of tartar; and the mixture burnt spontaneously, though it contained no hepar sulphuris or vitriolic acid. Having by these experiments evinced that metallic pyrophori may be prepared without vitriolic acid, Mr Bewly proceeded to form an aluminous pyrophorus of the same kind. For this purpose he procured the earth of alum by a long and violent calcination; and examining a part of it, he found, by the usual tests, that it neither contained any sulphur, hepar sulphuris, nor alum undecomposed. This he considered as perfectly pure, though he afterwards found that it contained a small quantity of vitriolated tartar; and yet it repeatedly furnished a pyrophorus, as active as when alum itself is employed. From these and similar experiments, he infers, that the several kinds of pyrophori are not kindled by moisture, attracted by the vitriolic acid, as M. De Sauvigny has maintained: and his conclusion is farther confirmed by some experiments of Dr Priestley; from which it appears, that they are kindled in dry, nitrous, and what he calls dephlogisticated air.

M. Proust, cited by Mr Bewly, describes a variety of new pyrophori, which neither contain vitriolic acid, nor seem likely to owe their accension to the attraction of humidity from the air. These principally consist of a coaly matter simply divided by metallic or other earths; such are the sediment left on the filter in preparing Goulard's extract, various combinations of tartar or its acid, or the acetous acid, with metals, calcareous earth, &c.

Mr Bewly, having evinced the insufficiency of M. De Sauvigny's theory, and discovered that the pyrophori are not kindled by moisture, attracted (merely) by the vitriolic acid, directed his attention to the nitrous acid, which Dr Priestley has shown to be a constituent part of atmospherical air, as the probable agent in the production of this phenomenon. The strong affinity which this acid has with phlogiston, and the heat, and even flame, which it is known to produce with certain inflammable matters, manifested that it was equal to the effect; and having excluded the vitriolic acid from having any essential concern in this operation, he suggests, either that the pyrophorus is kindled by moisture attracted by some of the other ingredients which compose it; or that it has the power of decomposing atmospherical air, by suddenly attracting its nitrous acid, and thereby generating a heat sufficient to kindle the phlogistic matter contained in it. This idea appeared plausible, when he farther considered that Dr Priestley produced the purest respirable air with this same acid combined with other principles; and that this as well as common air is diminished, and probably in part decomposed, in a variety of phlogistic processes. This ingenious writer concludes, upon the whole, from the experiments he hath made, that the pyrophorus seems to owe its singular property to its being a combination of earth or alkali with phlogiston; the vitriolic acid, when present, only occasionally increasing or diminishing the effect, according to circumstances. In the process of calcination, the earth or alkaline principle is not merely mixed, but actually, though loosely, combined with the phlogistic principle of the coal; so that the pyrophorus,

considering it in its most simple state, is only a perfectly dry phlogisticated alkali or earth. On these data, the phenomena may be explained in the two following methods; with respect particularly to the influence of moisture and heat upon the pyrophorus. Supposing either the alkaline or earthy principle to have a greater affinity to water than to the phlogiston with which either of them is united, they may, on being exposed to a moist atmosphere, attract the humidity, and thereby set the phlogistic principle at liberty; which may, in its turn, attract, and be ignited by, the supposed aerial acid; its strong affinity to which is well known:—or, if this hypothesis be rejected, the inflammable matter may be kindled, merely in consequence of the heat produced by the combination of the alkali, &c. with moisture.

Mr Keir gives the following description of a process for preparing a new pyrophorus which he has lately discovered: "I filled about five-sixths of the contents of a copper cylindrical box, which had a lid fitted to it, and which was three inches in diameter and two inches in depth, with saw-dust, which I pressed down; and I laid upon the saw-dust as much well-washed *plumbum corneum* as entirely filled the box, which I then covered with its lid. I placed the box on the coals of a chamber-fire, so that its bottom only should be in contact with the fuel, and I kept it on the fire till no more vapour seemed to issue at the joining of the lid. I then removed it from the fire; and while it was hot, I closed up the joining of the lid with sealing-wax, by which means the external air was excluded. After it had stood in the cold about ten hours, I opened the box; and the corneous lead, which was very white before the operation, was now rendered black by the vapour which had arisen from the saw-dust, and which was obliged to pass through the lead before it could escape. This black metallic mass was no sooner exposed to the air, than ignited sparks appeared, which spread more and more, while the lead was seen to revive in the form of minute globules, and the part which did not revive was changed into a yellow powder, or calx of lead. It is to be observed, that before I opened the box, I placed it at the side of the fire, in order to melt the sealing-wax, to enable me to separate the lid. It is possible that this small degree of heat may be necessary, or conducive, to the accension. I ought also to acquaint you, that the preparation of this pyrophorus requires nicer attention than that of any which I am acquainted with. For a small excess of heat will revive the lead, which will spoil the experiment. Also, if any air be admitted through the joints of the vessels employed, the kindling property will be prevented by the absorption of the air; which in this case is generally too gradual to produce inflammation. The metallic substance in this state of impregnation with inflammable matter, although not a pyrophorus, is an exceeding quick tinder. For when touched, however slightly, by an ignited body, it will instantly kindle, and the fire will spread over the whole piece, reviving the lead wherever it goes, and exhibiting a very beautiful example of metallic reduction, not unlike the familiar experiment of reviving the lead of a wafer containing minium at the flame of a candle; but with this difference, that the fire in the wafer requires to be kept up by flame; whereas in this metallic tinder it spreads and creeps spontaneously along without flame over the mass.

Pyropho-
rus.

P Y R O T E C H N Y;

Ingredients and Compositions. **T**HE art of fire, or a science which teaches the management and application of fire in several operations. See FIRE, FURNACE, CHEMISTRY, DISTILLATION, METALLURGY, &c.

But the term is more particularly used to denote the doctrine of artificial fire-works and fire-arms, teaching the structure and use, 1. Of those used in war, the attacking of fortifications, &c. for which see the articles FUSEE, GUN, GUNNERY, GUNPOWDER, MINE, &c.; and, 2. Of those made for amusement's sake, as rockets, stars, serpents, &c. the preparation and construction of which fall to be explained in the present article.

SECT. I. *Of Ingredients and Compositions.*1. *Saltpetre.*

Captain Jones's Artificial Fire-works.

Saltpetre being the principal ingredient in fire-works, and a volatile body, by reason of its aqueous and aerial parts, is easily rarefied by fire; but not so soon when foul and gross as when purified from its crude and earthy parts, which greatly retard its velocity: therefore, when any quantity of fire-works are to be made, it should be examined; for if it is not well cleansed, and of a good sort, your works will not have their proper effect; neither will it agree with the standing proportions of compositions. Therefore,

To refine it, put into a copper, or any other vessel, 100 lb. of rough nitre with 14 gallons of clean water; let it boil gently half an hour, and as it boils take off the scum; then stir it, and before it settles put it into your filtering bags, which must be hung on a rack, with glazed earthen pans under them, in which must be sticks laid across for the crystals to adhere to: it must stand in the pans two or three days to shoot; then take out the crystals, and let them dry. The water that remains in the pans boil again an hour, and strain it into the pans as before, and the saltpetre will be quite clear and transparent; if not, it wants more refining; to do which proceed as usual, till it is well cleansed of all its earthy parts.

N. B. Those who do not choose to procure their saltpetre by the above method, may buy it ready done, which for fire-works in general will do.

To pulverise Saltpetre. Take a copper kettle, whose bottom must be spherical, and put into it 14 lb. of refined saltpetre, with 2 quarts or 5 pints of clean water: then put the kettle on a slow fire; and when the saltpetre is dissolved, if any impurities arise, skim them off, and keep constantly stirring with two large spatulas, till all the water exhales; and when done enough, it will appear like white sand, and as fine as flour; but if it should boil too fast, take the kettle off the fire, and set it on some wet sand, which will prevent the nitre from sticking to the kettle. When you have pulverised a quantity of saltpetre, be careful to keep it in a dry place.

To extract Saltpetre from damaged Gunpowder.—Have some filtering bags, hung on a rack, with glazed earthen pans under them, in the same manner as those

for refining saltpetre; then take any quantity of damaged powder, and put it into a copper, with as much clean water as will cover it: when it begins to boil, take off the scum; and after it has boiled a few minutes, stir it up: then take it out of the copper with a small hand-kettle for that purpose, and put some into each bag, beginning at one end of the rack, so that by the time you have got to the last bag, the first will be ready for more. Continue thus till all the bags are full: then take the liquor out of the pans; which boil and filter, as before, two or three times, till the water run quite clear, which you must let stand in the pan some time, and the saltpetre will appear at top. To get the saltpetre entirely out of the powder, take the water from that already extracted, to which add some fresh and the dregs of the powder that remain in the bags, and put them in a vessel, to stand as long as you please: and when you want to extract the nitre, you must proceed with this mixture as with the powder at first, by which means you will draw out all the saltpetre; but this process must be boiled longer than the first.

2. *Sulphur, or Brimstone.*

Sulphur is one of the principal ingredients in gunpowder, and almost in all compositions of fire-works; and therefore great care must be taken of its being good, and brought to the highest perfection. To know when sulphur is good, you are to observe that it is of a high yellow; and if, when held in one's hand, it crackles and bounces, it is a sign that it is fresh and good: but as the method of reducing brimstone to a powder is very troublesome, it is better to buy the flour ready made, which is done in large quantities, and in great perfection; though when a grand collection of fire-works are to be made, the strongest and best sulphur is the lump brimstone ground in the manner directed in art. 8.

3. *Charcoal.*

Charcoal is a preservative by which the saltpetre and the brimstone are made into gunpowder, by preventing the sulphur from suffocating the strong and windy exhalation of the nitre. Charcoal for fire-works must always be soft and well burnt, which may be bought ready done.

4. *Gunpowder.*

See GUNPOWDER in the order of the alphabet. To grind or meal it, is directed in art. 8.

5. *Camphor.*

This may be had in the shops; and is of two kinds, differing in regard to the degree of their purity, and distinguished by the name of *rough* and *refined*. Refined camphor must be chosen of a perfectly clean white colour, very bright and pellucid, of the same smell and taste with the rough; but more acrid and pungent. It is so volatile, that merchants usually inclose it in lintseed, that the viscosity of that grain may keep its particles together.

6. *Benjamin.*

This is a resin found of different sorts; and distinguished by their colours, viz. yellow, grey, and brown; but the best is that which is easy to break, and full of white

Ingredients
and
Composi-
tions.

white spots. It is one of the ingredients in odoriferous fire-works, when reduced to a fine flour; which may be done by putting into a deep and narrow earthen pot 3 or 4 oz. of benjamin grossly pounded; cover the pot with paper, which tie very close round the edge; then set the pot on a slow fire, and once in an hour take off the paper, and you will find some flour sticking to it, which return again in the pot; this you must continue till the flour appears white and fine. There is also an oil of benjamin, which is sometimes drawn from the dregs of the flour; it affords a very good scent, and may be used in wet compositions.

7. *Spur-fire.*

This fire is the most beautiful and curious of any yet known; and was invented by the Chinese, but now is in greater perfection in England than in China. As it requires great trouble to make it to perfection, it will be necessary that beginners should have full instructions; therefore care should be taken that all the ingredients are of the best, that the lamp-black is not damp and clodded, that the saltpetre and brimstone are thoroughly refined. This composition is generally rammed in 1 or 2 oz. cases about 5 or 6 inches long, but not drove very hard; and the cases must have their concave stroke struck very smooth, and the choak or vent not quite so large as the usual proportion: this charge, when driven and kept a few months, will be much better than when rammed; and will not spoil, if kept dry, in many years.

As the beauty of this composition cannot be seen at so great a distance as brilliant fire, it has a better effect in a room than in the open air, and may be fired in a chamber without any danger: it is of so innocent a nature, that, though with an improper phrase, it may be called a *cold fire*; and so extraordinary is the fire produced from this composition, that, if well made, the sparks will not burn a handkerchief when held in the midst of them; you may hold them in your hand while burning, with as much safety as a candle; and if you put your hand within a foot of the mouth of the case, you will feel the sparks like drops of rain.—When any of these spur-fires are fired singly, they are called *artificial flower-pots*; but some of them placed round a transparent pyramid of paper, and fired in a large room, make a very pretty appearance.

The composition consists of saltpetre 4 lb. 8 oz. sulphur 2 lb. and lamp-black 1 lb. 8 oz.; or, saltpetre 1 lb. sulphur $\frac{1}{2}$ lb. and lamp-black 4 quarts.—This composition is very difficult to mix. The saltpetre and brimstone must be first sifted together, and then put into a marble mortar, and the lamp-black with them, which you work down by degrees with a wooden pestle, till all the ingredients appear of one colour, which will be something greyish, but very near black: then drive a little into a case for trial, and fire it in a dark place; and if the sparks, which are called *stars*, or *pinks*, come out in clusters, and afterwards spread well without any other sparks, it is a sign of its being good, otherwise not; for if any drossy sparks appear, and the stars not full, it is then not mixed enough; but if the pinks are very small, and soon break, it is a sign that you have rubbed it too much.

This mixture, when rubbed too much, will be too fierce, and hardly show any stars; and, on the contrary, when not mixed enough, will be too weak, and

throw out an obscure smoke, and lumps of dross, with-Ingredients
out any stars. The reason of this charge being called the *spur-fire*, is because the sparks it yields have a great resemblance to the rowel of a spur, from whence it takes its name.

8. *To meal Gunpowder, Brimstone, and Charcoal.*

There have been many methods used to grind these ingredients to a powder for fire-works, such as large mortars and pestles made of ebony and other hard wood, and horizontal mills with brass barrels: but none have proved so effectual and speedy as the last invention, that of the mealing-table, represented in fig. 1. made of elm, with a rim round its edge 4 or 5 inches high; and at the narrow end A, is a slider that runs in a groove, and forms part of the rim: so that when you have taken out of the table as much powder as you can with the copper shovel (fig. 2.) sweep all clean out at the slider A. When you are going to meal a quantity of powder, observe not to put too much in the table at once; but when you have put in a good proportion, take the muller (fig. 3.) and rub it till all the grains are broke: then scarce it in a lawn sieve that has a receiver and top to it; and that which does not pass through the sieve, return again to the table, and grind it till you have brought it all fine enough to go through the sieve. Brimstone and charcoal are ground in the same manner, only the muller must be made of ebony; for these ingredients being harder than powder, would stick in the grain of elm, and be difficult to grind. As brimstone is apt to stick and clod to the table, it will be best to keep one for that purpose, by which means you will always have your brimstone clean and well ground.

2d 8. *To make Wheels and other Works incombustible.*

It being necessary, when your works are new, to paint them of some dark colour; therefore, if, instead of which, you make use of the following composition, it will give them a good colour, and in a great measure prevent their taking fire so soon as if painted. Take brick-dust, coal-ashes, and iron-filings, of each an equal quantity, and mix them with a double size, made hot. With this wash over your works, and when dry wash them over again; this will preserve the wood greatly against fire. Let the brick-dust and ashes be beat to a fine powder.

9. *To prepare Cast-iron for Gerbes, white Fountains, and Chinese Fire.*

Cast iron being of so hard a nature as not to be cut by a file, we are obliged to reduce it into grains, though somewhat difficult to perform; but if we consider what beautiful sparks this sort of iron yields, no pains should be spared to granulate such an essential material: to do which, get at an iron-foundry some thin pieces of iron, such as generally run over the mould at the time of casting: then have a square block made of cast iron, and an iron square hammer about four lb. weight; then, having covered the floor with cloth or something to catch the beatings, lay the thin pieces of iron on the block, and beat them with the hammer till reduced into small grains; which afterwards scarce with a very fine sieve, to separate the fine dust, which is sometimes used in small cases of brilliant fire, instead of steel dust; and when you have got out all the dust, sift what remains with a sieve a little larger, and so on with sieves of different sizes, till

Plate
CCCCXXVII

Ingredients
and
Composi-
tions.

till the iron passes through about the bigness of small bird-shot: your iron thus beat and sifted, put each sort into wooden boxes or oiled paper, to keep it from rusting. When you use it, observe the difference of its size, in proportion to the cases for which the charge is intended; for the coarse sort is only designed for very large gerbes of 6 or 8 lb.

10. Charges for Sky-rockets, &c.

Rockets of four ounces. Mealed powder 1 lb. 4 oz. saltpetre 4 oz. and charcoal 2 oz.

Rockets of eight ounces. I. Mealed powder 1 lb. saltpetre 4 oz. brimstone 3 oz. and charcoal 1½ oz. II. Meal-powder 1½ lb. and charcoal 4½ oz.

Rockets of one pound. Meal-powder 2 lb. saltpetre 8 oz. brimstone 4 oz. charcoal 2 oz. and steel-filings 1½ oz.

Sky-rockets in general. I. Saltpetre 4 lb. brimstone 1 lb. and charcoal 1½ lb. II. Saltpetre 4 lb. brimstone 1½ lb. charcoal 1 lb. 12 oz. and meal-powder 2 oz.

Large sky-rockets. Saltpetre 4 lb. meal-powder 1 lb. and brimstone 1 lb.

Rockets of a middling size. I. Saltpetre 8 lb. sulphur 3 lb. meal-powder 3 lb. II. Saltpetre 3 lb. sulphur 2 lb. meal-powder 1 lb. charcoal 1 lb.

11. For Rocket Stars.

White Stars. Meal-powder 4 oz. saltpetre 12 oz. sulphur vivum 6 oz. oil of spike 2 oz. and camphor 5 oz.

Blue stars. Meal-powder 8 oz. saltpetre 4, sulphur 2, spirit of wine 2, and oil of spike 2.

Coloured or variegated stars. Meal-powder 8 drams, rochpetre 4 oz. sulphur vivum 2, and camphor 2.

Brilliant stars. Saltpetre 3½ oz. sulphur 1½, and meal-powder ½, worked up with spirits of wine only.

Common stars. Saltpetre 1 lb. brimstone 4 oz. antimony 4½, isinglass ½, camphor ½, and spirit of wine ¾.

Tailed stars. Meal-powder 3 oz. brimstone 2, saltpetre 1, and charcoal (coarsely ground) ¾.

Drove stars. I. Saltpetre 3 lb. sulphur 1 lb. brimstone 12 oz. antimony 3. II. Saltpetre 1 lb. antimony 4 oz. and sulphur 8.

Fixed pointed stars. Saltpetre 8½ oz. sulphur 2, antimony 1 oz. 10 dr.

Stars of a fine colour. Sulphur 1 oz. meal-powder 1, saltpetre 1, camphor 4 dr. oil of turpentine 4 dr.

12. Rains.

Gold rain for sky-rockets. I. Saltpetre 1 lb. meal-powder 4 oz. sulphur 4, brimstone 1, saw-dust 2½, and glass-dust 6 dr. II. Meal-powder 12 oz. saltpetre 2, charcoal 4. III. Saltpetre 8 oz. brimstone 2, glass-dust 1, antimony ¾, brimstone ½, and saw-dust 12 dr.

Silver rain. I. Saltpetre 4 oz. sulphur, meal-powder, and antimony, of each 2 oz. sal prunella ½ oz. II. Saltpetre ½ lb. brimstone 2 oz. and charcoal 4. III. Saltpetre 1 lb. brimstone ½ lb. antimony 6 oz. IV. Saltpetre 4 oz. brimstone 1, powder 2, and steel-dust ¾ oz.

13. Water Rockets.

I. Meal-powder 6 lb. saltpetre 4, brimstone 3, charcoal 5. II. Saltpetre 1 lb. brimstone 4½ oz. charcoal 6. III. Saltpetre 1 lb. brimstone 4 oz. charcoal 12. IV. Saltpetre 4 lb. brimstone 1½ lb. charcoal 1 lb. 12

VOL. XV. Part II.

oz. V. Brimstone 2 lb. saltpetre 4 lb. and meal. VI. Saltpetre 1 lb. meal-powder 4 oz. brimstone 8½, charcoal 2. VII. Meal-powder 1 lb. saltpetre 3, brimstone 1; sea-coal 1 oz. charcoal 8½, saw-dust ½, steel-dust ½, and coarse charcoal ½ oz. VIII. Meal-powder 1½ lb. saltpetre 3, sulphur 1½, charcoal 12 oz. saw-dust 2.

Sinking charge for water-rockets. Meal-powder 8 oz. charcoal ¾ oz.

14. Of Wheels.

Wheel-cases from two ounces to four pounds. I. Meal-powder 2 lb. saltpetre 4 oz. iron-filings 7. II. Meal-powder 2 lb. saltpetre 12 oz. sulphur 4, steel-dust 3. III. Meal-powder 4 lb. saltpetre 1 lb. brimstone 8 oz. charcoal 4½. IV. Meal-powder 8 oz. saltpetre 4, saw-dust 1½, sea-coal ½. V. Meal-powder 1 lb. 4 oz. brimstone 4 oz. 10 dr. saltpetre 8 oz. glass-dust 2½. VI. Meal-powder 12 oz. charcoal 1, saw-dust ½. VII. Saltpetre 1 lb. 9 oz. brimstone 4 oz. charcoal 4½. VIII. Meal-powder 2 lb. saltpetre 1, brimstone ½, and sea-coal 2 oz. IX. Saltpetre 2 lb. brimstone 1, meal-powder 4, and glass-dust 4 oz. X. Meal-powder 1 lb. saltpetre 2 oz. and steel-dust 3½. XI. Meal-powder 2 lb. and steel-dust 2½ oz. with 2½ of the fine dust of beat iron. XII. Saltpetre 2 lb. 13 oz. brimstone 8 oz. and charcoal.

Slow fire for wheels. I. Saltpetre 4 oz. brimstone 2, and meal-powder 1½. II. Saltpetre 4 oz. brimstone 1, and antimony 1 oz. 6 dr. III. Saltpetre 4½ oz. brimstone 1 oz. and mealed powder 1½.

Dead fire for wheels. I. Saltpetre 1½ oz. brimstone ½, lapis-calaminaris ½, and antimony 2 dr.

15. Standing or fixed Cases.

I. Meal-powder 4 lb. saltpetre 2, brimstone and charcoal 1. II. Meal-powder 2 lb. saltpetre 1, and steel-dust 8 oz. III. Meal-powder 1 lb. 4 oz. and charcoal 4 oz. IV. Meal-powder 1 lb. and steel-dust 4 oz. V. Meal-powder 2½ lb. brimstone 4 oz. and sea-coal 6. VI. Meal-powder 3 lb. charcoal 5 oz. and saw-dust 1½.

16. Sun Cases.

I. Meal-powder 8½ lb. saltpetre 1 lb. 2 oz. steel-dust 2 lb. 10 oz. brimstone 4. II. Meal-powder 3 lb. saltpetre 6 oz. and steel-dust 7½.

17. A brilliant Fire.

Meal-powder 11 lb. saltpetre 1, brimstone 4 oz. steel-dust 1½ lb.

18. Gerbes.

Meal-powder 6 lb. and beat-iron 2 lb. 1½ oz.

19. Chinese Fire.

Saltpetre 12 oz. meal-powder 2 lb. brimstone 1 lb. 2 oz. and beat iron 12 oz.

20. Tourbillons.

Charge for four-ounce Tourbillons. Meal-powder 2 lb. 4 oz. and charcoal 4½ oz.

Eight-ounce Tourbillons. Meal-powder 2 lb. and charcoal 4½ oz.

Large Tourbillons. Meal-powder 2 lb. saltpetre 1, brimstone 8 oz. and beat iron 8.

N. B. Tourbillons may be made very large, and of different coloured fires: only you are to observe, that the larger they are, the weaker must be the charge; and, on the contrary, the smaller, the stronger their charge.

Ingredients
and
Composi-
tions.

21. *Water Balloons.*

I. Saltpetre 4 lb. brimstone 2, meal-powder 2, antimony 4 oz. saw-dust 4, and glass-dust $1\frac{1}{2}$. II. Saltpetre 9 lb. brimstone 3 lb. meal-powder 6 lb. rosin 12 oz. and antimony 8 oz.

22. *Water Squibs.*

I. Meal-powder 1 lb. and charcoal 1 lb. II. Meal-powder 1 lb. and charcoal 9 oz.

23. *Mine Ports or Serpents.*

I. Meal-powder 1 lb. and charcoal 1 oz. II. Meal-powder 9 oz. charcoal 1 oz.

24. *Port-fires.*

For firing rockets, &c. I. Saltpetre 12 oz. brimstone 4 oz. and meal-powder 2 oz. II. Saltpetre 8 oz. brimstone 4 oz. and meal-powder 2 oz. III. Saltpetre 1 lb. 2 oz. meal-powder $1\frac{1}{2}$ lb. and brimstone 10 oz. This composition must be moistened with one gill of linseed oil. IV. Meal-powder 6 oz. saltpetre 2 lb. 2 oz. and brimstone 10 oz. V. Saltpetre 1 lb. 4 oz. meal-powder 4 oz. brimstone 5 oz. saw-dust 8 oz. VI. Saltpetre 8 oz. brimstone 2 oz. and meal-powder 2 oz.

For illuminations. Saltpetre 1 lb. brimstone 8 oz. and meal-powder 6 oz.

25. *Cones or spiral Wheels.*

Saltpetre $1\frac{1}{2}$ lb. brimstone 6 oz. meal-powder 14 oz. and glass-dust 14 oz.

26. *Crowns or Globes.*

Saltpetre 6 oz. brimstone 2 lb. antimony 4 oz. and camphor 2 oz.

27. *Air Balloon Fuzes.*

I. Saltpetre 1 lb. 10 oz. brimstone 8 oz. and meal-powder 1 lb. 6 oz. II. Saltpetre $1\frac{1}{2}$ lb. brimstone 8 oz. and meal-powder 1 lb. 8 oz.

28. *Serpents for Pots des Brins.*

Meal-powder 1 lb. 8 oz. saltpetre 12 oz. and charcoal 2 oz.

29. *Fire Pumps.*

I. Saltpetre 5 lb. brimstone 1 lb. meal-powder $1\frac{1}{2}$ lb. and glass-dust 1 lb. II. Saltpetre 5 lb. 8 oz. brimstone 2 lb. meal-powder 1 lb. 8 oz. and glass-dust 1 lb. 8 oz.

30. *A slow white Flame.*

I. Saltpetre 2 lb. brimstone 3 lb. antimony 1 lb. II. Saltpetre $3\frac{1}{2}$ lb. sulphur $2\frac{1}{2}$ lb. meal-powder 1 lb. antimony $\frac{1}{2}$ lb. glass-dust 4 oz. brass-dust 1 oz.

N. B. These compositions, driven $1\frac{1}{2}$ inch in a 1 oz. case, will burn one minute, which is much longer time than an equal quantity of any composition yet known will last.

31. *Amber Lights.*

Meal-powder 9 oz. amber 3 oz. This charge may be drove in small cases, for illuminations.

32. *Lights of another Kind.*

Saltpetre 3 lb. brimstone 1 lb. meal-powder 1 lb. antimony $10\frac{1}{2}$ oz. All these must be mixed with the oil of spike.

33. *A red Fire.*

Meal-powder 3 lb. charcoal 12 oz. and saw-dust 8 oz.

34. *A common Fire.*

Saltpetre 3 lb. charcoal 10 oz. and brimstone 2 oz.

35. *To make an artificial Earthquake.*

Mix the following ingredients to a paste with water, and then bury it in the ground, and in a few hours the

earth will break and open in several places. The composition: sulphur 4 lb. and steel-dust 4 lb.

36. *Compositions for Stars of different Colours.*

I. Meal-powder 4 oz. saltpetre 2 oz. brimstone 2 oz. steel-dust $1\frac{1}{2}$ oz. and camphor, white amber, antimony, and mercury-sublimate, of each $\frac{1}{2}$ oz. II. Rochepetre 10 oz. brimstone, charcoal, antimony, meal-powder, and camphor, of each $\frac{3}{4}$ oz. moistened with oil of turpentine. These compositions are made into stars, by being worked to a paste with aqua vitæ, in which has been dissolved some gum-tragacanth; and after you have rolled them in powder, make a hole through the middle of each, and string them on quick-match, leaving about 2 inches between each. III. Saltpetre 8 oz. brimstone 2 oz. yellow amber 1 oz. antimony 1 oz. and powder 3 oz. IV. Brimstone $2\frac{1}{2}$ oz. saltpetre 6 oz. olibanum or frankincense in drops 4 oz.; mastick, and mercury-sublimate, of each 4 oz. meal-powder 5 oz. white amber, yellow amber, and camphor, of each 1 oz. antimony and orpiment $\frac{1}{2}$ oz. each. V. Saltpetre 1 lb. brimstone $\frac{1}{2}$ lb. and meal-powder 8 oz. moistened with petroleo-oil. VI. Powder $\frac{1}{2}$ lb. brimstone and saltpetre, of each 4 oz. VII. Saltpetre 4 oz. brimstone 2 oz. and meal-powder 1 oz.

Stars that carry tails of sparks. I. Brimstone 6 oz. antimony crude 2 oz. saltpetre 4 oz. and rosin 4 oz. II. Saltpetre, rosin, and charcoal, of each 2 oz. brimstone 1 oz. and pitch 1 oz.

These compositions are sometimes melted in an earthen pan, and mixed with chopped cotton-match, before they are rolled into stars; but will do as well if wetted, and worked up in the usual manner.

Stars that yield some sparks. I. Camphor 2 oz. saltpetre 1 oz. meal-powder 1 oz. II. Saltpetre 1 oz. ditto melted $\frac{1}{2}$ oz. and camphor 2 oz. When you would make stars of either of these compositions, you must wet them with gum-water, or spirit of wine, in which has been dissolved some gum-arabic, or gum-tragacanth, that the whole may have the consistence of a pretty thick liquid; having thus done, take 1 oz. of lint, and stir it about in the composition till it becomes dry enough to roll into stars.

Stars of a yellowish colour. Take 4 oz. of gum-tragacanth or gum-arabic, pounded and sifted through a fine sieve, camphor dissolved in brandy 2 oz. saltpetre 1 lb. sulphur $\frac{1}{2}$ lb. coarse powder of glass 4 oz. white amber $1\frac{1}{2}$ oz. orpiment 2 oz. Being well incorporated, make them into stars after the common method.

Stars of another kind. Take 1 lb. of camphor, and melt it in a pint of spirit of wine over a slow fire; then add to it 1 lb. of gum-arabic that has been dissolved; with this liquor mix 1 lb. of saltpetre, 6 oz. of sulphur, and 5 oz. of meal-powder; and after you have stirred them well together, roll them into stars proportionable to the rockets for which you intend them.

37. *Colours produced by the different Compositions.*

As variety of fires adds greatly to a collection of works, it is necessary that every artist should know the different effect of each ingredient. For which reason, we shall here explain the colours they produce of themselves; and likewise how to make them retain the same when mixed with other bodies: as for example, sulphur

Ingredients
and
Composi-
tions.

Ingredients
and
Composi-
tions.

fulphur gives a blue, camphor a white or pale colour, saltpetre a clear white-yellow, amber a colour inclining to yellow, sal-ammoniac a green, antimony a reddish, rosin a copper colour, and Greek-pitch a kind of bronze, or between red and yellow. All these ingredients are such as show themselves in a flame, viz.

White flame. Saltpetre, sulphur, meal-powder, and camphor; the saltpetre must be the chief part

Blue flame. Meal-powder, saltpetre, and sulphur vivum; sulphur must be the chief: Or meal-powder, saltpetre, brimstone, spirit of wine, and oil of spike; but let the powder be the principal part.

Flame inclining to red. Saltpetre, sulphur, antimony, and Greek-pitch; saltpetre the chief.

By the above method may be made various colours of fire, as the practitioner pleases; for, by making a few trials, he may cause any ingredient to be predominant in colour.

38. *Ingredients that show in Sparks when rammed in choaked Cases.*

The set colours of fire produced by sparks are divided into 4 sorts, viz. the black, white, grey, and red. The black charges are composed of 2 ingredients, which are meal-powder and charcoal; the white of 3, viz. saltpetre, sulphur, and charcoal; the grey of 4, viz. meal-powder, saltpetre, brimstone, and charcoal; and the red of 3, viz. meal-powder, charcoal, and saw-dust.

There are, besides these four regular or set charges, two others, which are distinguished by the names of *compound* and *brilliant charges*; the compound being made of many ingredients, such as meal-powder, saltpetre, brimstone, charcoal, saw-dust, sea-coal, antimony, glass dust, brass dust, steel filings, cast iron, tanner's dust, &c. or any thing that will yield sparks; all which must be managed with discretion. The brilliant fires are composed of meal-powder, saltpetre, brimstone, and steel dust; or with meal-powder and steel filings only.

39. *Cotton Quick-match,*

Is generally made of such cotton as is put in candles, of several sizes, from 1 to 6 threads thick, according to the pipe it is designed for; which pipe must be large enough for the match, when made, to be pushed in easily without breaking it. Having doubled the cotton into as many threads as you think proper, coil it very lightly into a flat-bottomed copper or earthen pan; then put in the saltpetre and the liquor, and boil them about 20 minutes; after which coil it again into another pan, as in fig. 4. and pour on it what liquor remains; then put in some meal-powder, and press it down with your hands till it is quite wet; afterwards place the pan before the wooden frame (fig. 5.) which must be suspended by a point in the centre of each end; and place yourself before the pan, tying the upper end of the cotton to the end of one of the sides of the frame.

When every thing is ready, you must have one to turn the frame round, while you let the cotton pass through your hands, holding it very lightly, and at the same time keeping your hands full of the wet powder; but if the powder should be too wet to stick to the cotton, put more in the pan, so as to keep a continual supply till the match is all wound up; you may wind it as close on the frame as you please, so that

it do not flick together; when the frame is full, take it off the points, and sift dry meal-powder on both sides the match, till it appear quite dry: in winter the match will be a fortnight before it is fit for use; when it is thoroughly dry, cut it along the outside of one of the sides of the frame, and tie it up in skins for use.

N. B. The match must be wound tight on the frames.

The ingredients for the match, are, cotton 1 lb. 12 oz. saltpetre 1 lb. spirit of wine 2 quarts, water 3 quarts, ifinglass 3 gills, and meal-powder 10 lb. To dissolve 4 oz. of ifinglass, take 3 pints of water.

2d 39. *Touch-paper for capping of Serpents, Crackers, &c.*

Dissolve, in spirits of wine or vinegar, a little saltpetre; then take some purple or blue paper, and wet it with this liquor, and when dry it will be fit for use; when you paste this paper on any of your works, take care that the paste does not touch that part which is to burn. The method of using this paper is by cutting it into slips, long enough to go once round the mouth of a serpent, cracker, &c. When you paste on these slips, leave a little above the mouth of the case not pasted; then prime the case with meal-powder, and twist the paper to a point.

SECT. II. *Of Moulds, Cases, Mixture, Instruments, &c.*

40. *Rocket moulds.*

As the performance of rockets depends much on their moulds, it is requisite to give a definition of them and their proportions: They are made and proportioned by the diameter of their orifice, which are divided into = parts. Fig. 6. represents a mould made by its diameter AB: Its height from C to D is 6 diameters and 2 thirds; from D to E is the height of the foot, which is 1 diameter and 2 thirds; F the cloak or cylinder, whose height is 1 diameter and 1-3d; it must be made out of the same piece as the foot, and fit tight in the mould; G an iron pin that goes through the cylinder to keep the foot fast; H the nipple, which is $\frac{1}{2}$ a diameter high, and 2-3ds thick, and of the same piece of metal as the former I, whose height is $3\frac{1}{2}$ diameters, and at the bottom is 1-3d of the diameter thick, and from thence tapering to 1-6th of the diameter. The best way to fix the piercer in the cylinder, is to make that part below the nipple long enough to go quite through the foot, and rivet at bottom. Fig. 7. is a former or roller for the cases, whose length from the handle is $7\frac{1}{2}$ diameters, and its diameter 2-3ds of the bore. Fig. 8. the end of the former, which is of the same thickness, and 1 diameter and 2-3ds long; the small part, which fits into the hole in the end of the roller when the case is pinching, is 1-6th and $\frac{1}{4}$ of the mould's diameter thick. Fig. 9. the first drift, which must be 6 diameters from the handle; and this, as well as all other rammers, must be a little thinner than the former, to prevent the facking of the paper when you are driving in the charge. In the end of this rammer is a hole to fit over the piercer: the line K marked on this is 2 diameters and 1-3d from the handle; so that, when you are filling the rocket, this line appears at top of the case: you must then take the 2d rammer (fig. 10.) which from the handle is 4

Of Moulds, diameters, and the hole for the piercer is $1\frac{1}{2}$ diameter long. Fig. 11. is the short and solid drift which you use when you have filled the case as high as the top of the piercer.

Rammers must have a collar of brags at the bottom, to keep the wood from spreading or splitting, and the same proportion must be given to all moulds, from 1 oz. to 6 lb. We mentioned nothing concerning the handles of the rammers; however, if their diameter be equal to the bore of the mould, and 2 diameters long, it will be a very good proportion: but the shorter you can use them, the better; for the longer the drift, the less will be the pressure on the composition by the blow given with the mallet.

Dimensions for Rocket Moulds, if the Rockets are rammed solid.

Weight of rockets.	Length of the moulds without their feet.	Interior diameter of the moulds.	Height of the nipples.
lb. oz.	Inches.	Inches.	Inches.
6 0	34,7	3,5	1,5
4 0	38,6	2,9	1,4
2 0	13,35	2,1	1,0
1 0	12,25	1,7	0,85
0 8	10,125	1,333, &c.	0,6
0 4	7,75	1,125	0,5
0 2	6,2	0,9	0,45
0 1	4,9	0,7	0,35
0 $\frac{1}{2}$	3,9	0,55	0,25
6 drams	3,5	0,5	0,225
4 drams	2,2	0,3	0,2

The diameter of the nipple must always be equal to that of the former.

The thickness of the moulds is omitted, being very immaterial, provided they are substantial and strong.

Our author advises those who make rockets for private amusement, not to ram them solid; for it requires a very skilful hand, and an expensive apparatus for boring them, which will be shown hereafter. Driving of rockets solid is the most expeditious method, but not so certain as ramming them over a piercer.

41. *Moulds for Wheel-cases or Serpents.*

Fig. 12. represents a mould, in which the cases are drove solid; L the nipple (A), with a point (n) at top, which, when the case is filling, serves to stop the neck, and prevent the composition from falling out, which without this point it would do; and, in consequence, the air would get into the vacancy in the charge, and at the time of firing cause the case to burst. These sort of moulds are made of any length or diameter, according as the cases are required; but the diameter of the rollers must be equal to half the bore, and the rammers made quite solid.

42. *To roll Rocket and other Cases.*

Sky-rocket cases are to be made $6\frac{1}{2}$ of their exterior diameter long; and all other cases that are to be

filled in moulds must be as long as the moulds, within half its interior diameter.

Rocket cases, from the smallest to 4 or 6 lb. are generally made of the strongest sort of cartridge paper, and rolled dry; but the large sort are made of pasted pasteboard. As it is very difficult to roll the ends of the cases quite even, the best way will be to keep a pattern of the paper for the different sorts of cases; which pattern should be somewhat longer than the case it is designed for, and on it marked the number of sheets required, which will prevent any paper being cut to waste. Having cut your papers of a proper size, and the last sheet for each case with a slope at one end, so that when the cases are rolled it may form a spiral line round the outside, and that this slope may always be the same, let the pattern be so cut for a guide. Before you begin to roll, fold down one end of the first sheet, so far that the fold will go 2 or 3 times round the former: then, on the double edge, lay the former with its handle off the table; and when you have rolled on the paper within 2 or 3 turns, lay the next sheet on that part which is loose, and roll it all on.

Having thus done, you must have a smooth board, about 20 inches long, and equal in breadth to the length of the case. In the middle of this board must be a handle placed lengthwise. Under this board lay your case, and let one end of the board lie on the table; then press hard on it, and push it forwards, which will roll the paper very tight: do this three or four times before you roll on any more paper. This must be repeated every other sheet of paper, till the case is thick enough; but if the rolling board be drawn backwards, it will loosen the paper: you are to observe, when you roll on the last sheet, that the point of the slope be placed at the small end of the roller. Having rolled your case to fit the mould, push in the small end of the former F, about 1 diameter from the end of the case, and put in the end-piece within a little distance of the former; then give the pinching cord one turn round the case, between the former and the end-piece; at first pull easy, and keep moving the case, which will make the neck smooth, and without large wrinkles. When the cases are hard to choak, let each sheet of paper (except the first and last, in that part where the neck is formed) be a little moistened with water: immediately after you have struck the concave stroke, bind the neck of the case round with small twine, which must not be tied in a knot, but fastened with two or three hitches.

Having thus pinched and tied the case so as not to give way, put it into the mould without its foot, and with a mallet drive the former hard on the end-piece, which will force the neck close and smooth. This done, cut the case to its proper length, allowing from the neck to the edge of the mouth half a diameter, which is equal to the height of the nipple; then take out the former, and drive the case over the piercer with the long rammer, and the vent will be of a proper size.

Wheel-cases must be drove on a nipple with a point to close

- (A) The nipple and cylinders to bear the same proportion as those for rockets.
(B) A round bit of brags, equal in length to the neck of the case, and flat at the top.

of Moulds close the neck, and make the vent of the size required; which, in most cafes, is generally $\frac{1}{4}$ of their interior diameter. As it is very often difficult, when the cafes are rolled, to draw the roller out, you may make a hole through the handle, and put in it a small iron pin, by which you may easily turn the former round and pull it out. Fig. 17. shows the method of pinching cafes; P a treddle, which, when pressed hard with the foot, will draw the cord tight, and force the neck as close as you please; Q a small wheel or pulley, with a groove round it for the cord to run in.

Cafes are commonly rolled wet, for wheels and fixed pieces; and when they are required to contain a great length of charge, the method of making those cafes is thus: Your paper must be cut as usual, only the last sheet must not be cut with a slope: having your paper ready, paste each sheet on one side; then fold down the first sheet as before directed: but be careful that the paste do not touch the upper part of the fold; for if the roller be wetted, it will tear the paper in drawing it out. In pasting the last sheet, observe not to wet the last turn or two in that part where it is to be pinched; for if that part be damp, the pinching cord will stick to it, and tear the paper; therefore, when you choak those cafes, roll a bit of dry paper once round the case, before you put on the pinching cord; but this bit of paper must be taken off after the case is choaked. The rolling board, and all other methods, according to the former directions for the rolling and pinching of cafes, must be used to these as well as all other cafes.

43. To make Tourbillon Cafes.

Those sort of cafes are generally made about 8 diameters long; but if very large, 7 will be sufficient: tourbillons will answer very well from 4 oz. to 2 lb. but when larger there is no certainty. The cafes are best rolled wet with paste, and the last sheet must have a straight edge, so that the case may be all of a thickness: when you have rolled your cafes after the manner of wheel-cafes, pinch them at one end quite close; then with the rammer drive the ends down flat, and afterwards ram in about $\frac{1}{3}$ of a diameter of dried clay. The diameter of the former for these cafes must be the same as for sky-rockets.

N. B. Tourbillons are to be rammed in moulds without a nipple, or in a mould without its foot.

44. Balloon Cafes, or Paper Shells.

First, you must have an oval former turned of smooth wood; then paste a quantity of brown or cartridge paper, and let it lie till the paste has quite soaked through; this done, rub the former with soap or grease, to prevent the paper from sticking to it; then lay the paper on in small slips, till you have made it $\frac{1}{3}$ of the thickness of the shell intended. Having thus done, set it to dry; and when dry, cut it round the middle, and the two halves will easily come off: but observe, when you cut, to leave about 1 inch not cut, which will make the halves join much better than if quite separated. When you have some ready to join, place the halves even together, paste a slip of paper round the opening to hold them together, and let that dry; then lay on paper all over as before, everywhere equal, excepting that end which goes downwards in the mortar, which may be a little thicker than the rest; for that part which receives the blow from the

powder in the chamber of the mortar consequently requires the greatest strength. When the shell is thoroughly dry, burn a round vent at top, with square iron, large enough for the fuze: this method will do for balloons from 4 inches 2-5ths, to 8 inches diameter; but if they are larger, or required to be thrown a great height, let the first shell be turned of elm, instead of being made of paper.

For a balloon of 4 inches 2-5ths, let the former be 3 inches 1-8th diameter, and $5\frac{1}{2}$ inches long. For a balloon of 5 inches, the diameter of the former must be 4 inches, and 8 inches long. For a balloon of 8 inches, let the diameter of the former be 5 inches and 15-16ths, and 11 inches 7-8ths long. For a 10-inch balloon, let the former be 7 inches 3-16ths diameter, and 14 inches long. The thickness of a shell for a balloon of 4 inches 2-5ths, must be $\frac{1}{4}$ inch. For a balloon of 5 inches, let the thickness of the paper be 5-8ths of an inch. For an 8-inch balloon, 7-8ths of an inch. And for a 10-inch balloon, let the shell be 1 inch 1-8th thick.

Shells that are designed for stars only, may be made quite round, and the thinner they are at the opening, the better; for if they are too strong, the stars are apt to break at the bursting of the shell: when you are making the shell, make use of a pair of calibres, or a round gage, so that you may not lay the paper thicker in one place than another; and also to know when the shell is of a proper thickness. Balloons must always be made to go easy into the mortars.

Cafes for illumination Port-fires. These must be made very thin of paper, and rolled on formers, from 2 to 5-8ths of an inch diameter, and from 2 to 6 inches long: they are pinched close at one end, and left open at the other. When you fill them, put in but a little composition at a time, and ram it in lightly, so as not to break the case: 3 or 4 rounds of paper, with the last round pasted, will be strong enough for these cafes.

Cafes and moulds for common Port-fires. Common port-fires are intended purposely to fire the works, their fire being very slow, and the heat of the flame so intense, that, if applied to rockets, leaders, &c. it will fire them immediately. Port-fires may be made of any length, but are seldom made more than 21 inches long: the interior diameter of port-fire moulds should be 10-16ths of an inch, and the diameter of the former $\frac{1}{2}$ inch. The cafes must be rolled wet with paste, and one end pinched, or folded down. The moulds should be made of brass, and to take in two pieces lengthwise; when the case is in the two sides, they are held together by brass rings, or hoops, which are made to fit over the outside. The bore of the mould must not be made quite through, so that there will be no occasion for a foot. Those port-fires, when used, are held in copper sockets, fixed on the end of a long stick: these sockets are made like port-crayons, only with a screw instead of a ring.

45. Of mixing the Compositions.

The performance of the principal part of fire-works depends much on the compositions being well mixed; therefore great care must be taken in this part of the work, particularly for the composition for sky-rockets. When you have 4 or 5 pounds of ingredients to mix, which is a sufficient quantity at a time (for a larger proportion

Of Moulds, Cafes, Mixtures, Instruments, &c.

Of Moulds,
Cases, Mix-
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ments, &c.

proportion will not do so well), first put the different ingredients together; then work them about with your hands, till you think they are pretty well incorporated: after which put them into a lawn sieve with a receiver and top to it; and if, after it is sifted, any remains that will not pass through the sieve, grind it again till fine enough; and if it be twice sifted, it will not be amiss; but the compositions for wheels and common works are not so material, nor need be so fine. But in all fixed works, from which the fire is to play regular, the ingredient must be very fine, and great care taken in mixing them well together; and observe, that in all compositions wherein are steel or iron filings, the hands must not touch; nor will any works which have iron or steel in their charge keep long in damp weather, unless properly prepared, according to the following directions.

46. To preserve Steel or Iron filings.

It sometimes may happen, that fire-works may be required to be kept a long time, or sent abroad; neither of which could be done with brilliant fires, if made with filings unprepared; for this reason, that the saltpetre being of a damp nature, it causes the iron to rust; the consequence of which is, that when the works are fired, there will appear but very few brilliant sparks, but instead of them a number of red and droffy sparks; and besides, the charge will be so much weakened, that if this was to happen to wheels, the fire will hardly be strong enough to force them round. But to prevent such accidents, prepare your filings thus: Melt in a glazed earthen pan some brimstone over a slow fire, and when melted throw in some filings; which keep stirring about till they are covered with brimstone: this you must do while it is on the fire; then take it off, and stir it very quick till cold, when you must roll it on a board with a wooden roller, till you have broke it as fine as corn powder; after which sift from it as much of the brimstone as you can. There is another method of preparing filings, so as to keep 2 or 3 months in winter; this may be done by rubbing them between the strongest sort of brown paper, which before has been moistened with lintseed oil.

N. B. If the brimstone should take fire, you may put it out, by covering the pan close at top: it is not of much signification what quantity of brimstone you use, so that there is enough to give each grain of iron a coat; but as much as will cover the bottom of a pan of about 1 foot diameter, will do for 5 or 6 pound of filings, or cast-iron for gerbes.

47. To drive or ram Sky-rockets, &c.

Rockets drove over a piercer must not have so much composition put in them at a time as when drove solid; for the piercer, taking up great part of the bore of the case, would cause the rammer to rise too high; so that the pressure of it would not be so great on the composition, nor would it be drove everywhere equal. To prevent this, observe the following rule: That for those rockets which are rammed over a piercer, let the ladle (c) hold as much composi-

tion as, when drove, will raise the drift $\frac{1}{4}$ the interior diameter of the case, and for those drove solid to contain as much as will raise it $\frac{1}{4}$ the exterior diameter of the case: ladles are generally made to go easy in the case, and the length of the scoop about $1\frac{1}{2}$ of its own diameter.

The change of rockets must always be drove 1 diameter above the piercer, and on it must be rammed $1\frac{3}{4}$ of a diameter of clay; through the middle of which bore a small hole to the composition, that, when the charge is burnt to the top, it may communicate its fire, through the hole, to the stars in the head. Great care must be taken to strike with the mallet, and with an equal force, the same number of strokes to each ladle-full of charge; otherwise the rockets will not rise with an uniform motion, nor will the composition burn equal and regular: for which reason they cannot carry a proper tail; for it will break before the rocket has got half way up, instead of reaching from the ground to the top, where the rocket breaks and disperses the stars, rains, or whatever is contained in the head. When you are ramming, keep the drift constantly turning or moving; and when you use the hollow rammers, knock out of them the composition now and then, or the piercer will split them. To a rocket of 4 oz. give to each ladle-full of charge 16 strokes; to a rocket of 1 lb. 28; to a 2-pounder, 36; to a 4-pounder, 42; and to a 6-pounder, 56: but rockets of a larger sort cannot be drove well by hand, but must be rammed with a machine made in the same manner as those for driving piles.

The method of ramming of wheel-cases, or any other sort, in which the charge is drove solid, is much the same as sky-rockets; for the same proportion may be observed in the ladle, and the same number of strokes given, according to their diameters, all cases being distinguished by their diameters. In this manner, a case, whose bore is equal to a rocket of 4 oz. is called a 4-oz. case, and that which is equal to an 8-oz rocket an 8-oz. case, and so on, according to the different rockets.

Having taught the method of ramming cases in moulds, we shall here say something concerning those filled without moulds; which method, for strong pasted cases, will do extremely well, and save the expence of making so many moulds. The reader must here observe, when he fills any sort of cases, to place the mould on a perpendicular block of wood, and not on any place that is hollow; for we have found by experience, that when cases were rammed on driving benches, which were formerly used, the works frequently miscarried, on account of the hollow resistance of the benches, which oft jarred and loosened the charge in the cases; but this accident never happens when the driving blocks are used (D).

When cases are to be filled without moulds, proceed thus. Have some nipples made of brass or iron, of several sorts and sizes, in proportion to the cases, and to screw or fix in the top of the driving block; when you have fixed in a nipple, make, at about $1\frac{1}{2}$ inch

(c) A copper scoop with a wooden handle.

(D) A piece of hard wood in the form of an anvil block.

Of Moulds
Cafes, Mix-
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Of Moulds,
Cafes, Mix-
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ments, &c.

inch from it, a square hole in the block, 6 inches deep and 1 inch diameter; then have a piece of wood, 6 inches longer than the case intended to be filled, and 2 inches square; on one side of it cut a groove almost the length of the case, whose breadth and depth must be sufficient to cover near $\frac{1}{2}$ the case; then cut the other end to fit the hole in the block, but take care to cut it so that the groove may be of a proper distance from the nipple; this half mould being made and fixed tight in the block, cut, in another piece of wood nearly of the same length as the case, a groove of the same dimensions as that in the fixed piece; then put the case on the nipple, and with a cord tie it and the 2 half-moulds together, and your case will be ready for filling.

The dimensions of the above-described half-moulds are proportionable for cases of 8 ounces; but notice must be taken, that they differ in size in proportion to the cases.

Note, The clay, mentioned in this article, must be prepared after this manner: Get some clay, in which there is no stones nor sand, and bake it in an oven till quite dry; then take it out and beat it to a powder, and afterwards sift it through a common hair-sieve, and it will be fit for use.

48. Proportion of Mallets.

The best wood for mallets is dry beech. If a person uses a mallet of a moderate size, in proportion to the rocket, according to his judgment, and if the rocket succeeds, he may depend on the rest, by using the same mallet; yet it will be necessary that cases of different sorts be drove with mallets of different sizes.

The following proportion of the mallets for rockets of any size, from 1 oz. to 6 lb. may be observed; but as rockets are seldom made less than 1 oz. or larger than 6 lb. we shall leave the management of them to the curious; but all cases under 1 oz. may be rammed with an oz. rocket mallet. Your mallets will strike more solid, by having their handles turned out of the same piece as the head, and made in a cylindrical form. Let their dimensions be worked by the diameters of the rockets: for example; let the thickness of the head be 3 diameters, and its length 4, and the length of the handle 5 diameters, whose thickness must be in proportion to the hand.

49. Proportion of Sky-rockets, and manner of heading them.

Fig. 13. represents a rocket complete without its stick, whose length from the neck is 5 diameters 1-6th: the cases should always be cut to this length after they are filled. M is the head, which is 2 diameters high, and 1 diameter 1-6th $\frac{1}{2}$ in breadth; N the cone or cap, whose perpendicular height must be 1 diameter 1-3d. Fig. 14. the collar to which the head is fixed: this is turned out of deal or any light wood, and its exterior diameter must be equal to the interior diameter of the head; 1-6th will be sufficient for its thickness, and round the outside edge must be a groove; the interior diameter of the collar must not be quite so wide as the exterior diameter of the rocket: when this is to be glued on the rocket, you must cut two or three rounds of paper off the case, which will make a shoulder for it to rest upon. Fig. 15. a former for the head: two or three rounds of paper well pasted will be enough for the head, which, when rolled, put the collar on that part of the former marked O, which must fit the inside of

it; then, with the pinching cord pinch the bottom of the head into the groove, and tie it with small twine. Fig. 16. a former for the cone. To make the caps, cut your paper in round pieces, equal in diameter to twice the length of the cone you intend to make; which pieces being cut into halves, will make two caps each, without wasting any paper; having formed the caps, paste over each of them a thin white paper, which must be a little longer than the cone, so as to project about $\frac{1}{2}$ an inch below the bottom: this projection of paper, being notched and pasted, serves to fasten the cap to the head.

When you load the heads of your rockets, with stars, rains, serpents, crackers, scrolls, or any thing else, according to your fancy, remember always to put 1 ladle-full of meal-powder into each head, which will be enough to burst the head, and disperse the stars, or whatever it contains: when the heads are loaded with any sort of cases, let their mouths be placed downwards; and after the heads are filled, paste on the top of them a piece of paper, before you put on the caps. As the size of the stars often differ, it would be needless to give an exact number for each rocket; but this rule may be observed, that the heads may be nearly filled with whatever they are loaded.

50. Decorations for Sky-rockets.

Sky-rockets bearing the pre-eminence of all fireworks, it will not be improper to treat of their various kinds of decorations, which are directed according to fancy. Some are headed with stars of different sorts, such as tailed, brilliant, white, blue, and yellow stars, &c.; some with gold and silver rain; others with serpents, crackers, fire-rolls, marrons; and some with small rockets, and many other devices, as the maker pleases.

Dimensions and poise of Rocket-sticks.

Weight of the rocket.	Length of the stick.	Thickness at top.	Breadth at top.	Square at bottom.	Poise from the point of the cone.
L. oz.	F. in.	Inches.	Inches.	Inches.	F. in.
6 0	14 0	1,5	1,85	0,75	4 1,5
4 0	12 10	1,25	1,40	0,625	3 9,
2 0	9 4	1,125	1,	0,525	2 9,
1 0	8 2	0,725	0,80	0,375	2 1,
	8 6	0,5	0,70	0,25	1 10,5
4	5 3	0,3750	0,55	0,35	1 8,5
2	4 1	0,3	0,45	0,15	1 3,
1	3 6	0,25	0,35	0,10	11 0,
$\frac{1}{2}$	2 4	0,125	0,20	0,16	8 0,
$\frac{1}{4}$	1 10 $\frac{1}{2}$	0,1	0,15	0,5	5 0,5

The last column on the right, in the above table, expresses the distance from the top of the cone, where the stick, when tied on, should balance the rocket, so as to stand in an equilibrium on one's finger or the edge of a knife. The best wood for the sticks is dry deal, made thus. When you have cut and planed the sticks according to the dimensions given in the table, cut, on one of the flat sides at the top, a groove the length of the rocket, and as broad as the stick will allow; then, on the opposite flat side, cut two notches for the cord, which ties on the rocket, to lie in; one of these notches must be near the top of the stick, and

Of Moulds,
Cases Mix-
ture, Instru-
ments, &c.

and the other facing the neck of the rockets; the distance between these notches may easily be known, for the top of the stick should always touch the head of the rocket. When your rockets and sticks are ready, lay the rockets in the grooves in the sticks, and tie them on. Those who, merely for curiosity, may choose to make rockets of different sizes, from those expressed in the table of dimensions, may find the length of their sticks, by making them for rockets, from $\frac{1}{4}$ oz. to 1 lb. 60 diameters of the rocket long; and for rockets above 1 lb. 50 or 52 diameters will be a good length; their thickness at top may be about $\frac{1}{2}$ a diameter, and their breadth a very little more; their square at bottom is generally equal to $\frac{1}{4}$ the thickness at top. But although the dimensions of the sticks be very nicely observed, you must depend only on their balance; for, without a proper counterpoise, your rockets, instead of mounting perpendicularly, will take an oblique direction, and fall to the ground before they are burnt out.

51. *Boring Rockets which have been driven solid.*

Fig. 18. represents the plan of an apparatus, or lathe, for boring of rockets. A the large wheel, which turns the small one B, that works the rammer C: these rammers are of different sizes according to the rockets; they must be of the same diameter as the top of the bore intended, and continue that thickness a little longer than the depth of the bore required, and their points must be like that of an augre: the thick end of each rammer must be made square, and all of the same size, so as to fit into one socket, wherein they are fastened by a screw D. E the guide for the rammer, which is made to move backwards and forwards: so that, after you have marked the rammer $3\frac{1}{2}$ diameters of the rocket from the point, set the guide, allowing for the thickness of the fronts of the rocket boxes, and the neck and mouth of the rocket; so that when the front of the large box is close to the guide, the rammer may not go too far up the charge. F, boxes for holding the rockets, which are made so as to fit one in another; their sides must be equal in thickness to the difference of the diameters of the rockets, and their interior diameters equal to the exterior diameters of the rockets. To prevent the rocket's turning round while boring, a piece of wood must be placed against the end of the box in the inside, and pressed against the tail of the rocket; this will also hinder the rammer from forcing the rocket backwards. G, a rocket in the box. H, a box that slides under the rocket-boxes to receive the borings for the rockets, which fall through holes made on purpose in the boxes; these holes must be just under the mouth of the rocket, one in each box, and all to correspond with each other.

Fig. 19. is a front view of the large rocket-box. I, an iron plate, in which are holes of different sizes, through which the rammer passes: this plate is fastened with a screw in the centre, so that when you change the rammer, you turn the plate round, but always let the hole you are going to use be at the bottom: the fronts of the other boxes must have holes in them to correspond with those in the plate. K, the lower part of the large box; which is made to fit the inside of the lathe, that all the boxes may move quite steady.

Fig. 20. is a perspective view of the lathe. L, the guide for the rammer, which is set by the screw at bottom.

Fig. 21. A view of the front of the guide facing the rammer. M, an iron plate, of the same dimensions as that on the front of the box, and placed in the same direction, and also to turn on a screw in the centre. N, the rocket-box which slides backwards and forwards: when you have fixed a rocket in the box, push it forwards against the rammer; and when you think the scoop of the rammer is full, draw the box back, and knock out the composition: this you must do till the rocket is bored, or it will be in danger of taking fire; and if you bore in a hurry, wet the end of the rammer now and then with oil to keep it cool.

Having bored a number of rockets, you must have taps of different sorts according to the rockets. These taps are a little longer than the bore: but when you use them, mark them $3\frac{1}{2}$ diameters from the point, allowing for the thickness of the rocket's neck; then, holding the rocket in one hand, you tap it with the other. One of these taps is represented by fig. 22. They are made in the same proportion as the fixed piercers, and are hollowed their whole length.

52. *Hand Machine used for boring of Rockets instead of a Lathe.*

These sort of machines answer very well, though not so expeditious as the lathes. But they are not so expensive to make, and they may be worked by one man; whereas the lathe will require three. Fig. 23. represents the machine. O, the rocket boxes, which are to be fixed, and not to slide as those in the lathe. PQ are guides for the rammers, that are made to slide together, as the rammer moves forward: the rammers for these sorts of machines must be made of a proper length, allowing for the thickness of the front of the boxes, and the length of the mouth and neck of the case; on the square end of these rammers must be a round shoulder of iron, to turn against the outside of the guide Q, by which means the guides are forced forwards. R, the flock which turns the rammer, and while turning must be pressed towards the rocket by the body of the man who works it; all the rammers are to be made to fit one flock.

To make large Gerbes.

Fig. 1. represents a wooden former; fig. 2. a gerbe complete, with its foot or stand. The cases for gerbes are made very strong, on account of the strength of the composition; which, when fired, comes out with great velocity: therefore, to prevent their burbling, the paper should be patted, and the cases made as thick at the top as at the bottom. They should also have very long necks, for this reason; first, that the particles of iron will have more time to be heated, by meeting with greater resistance in getting out, than with a short neck, which would be burnt too wide before the charge be consumed, and spoil the effect: secondly, that with long necks the stars will be thrown to a great height, and will not fall before they are spent, or spread too much; but, when made to perfection, will rise and spread in such a manner as to form exactly a wheat-sheaf.

In the ramming of gerbes, there will be no need of a mould, the cases being sufficiently strong to support themselves.

Plate
ccccxix.

Of Moulds, themselves. But you are to be careful, before you begin to ram, to have a piece of wood made to fit in the neck; for if this be not done, the composition will fall into the neck, and leave a vacancy in the case, which will cause the case to burst so soon as the fire arrives at the vacancy. You must likewise observe, that the first ladle of charge, or second, if you think proper, be of some weak composition. When the case is filled, take out the piece of wood, and fill the neck with some slow charge. Gerbes are generally made about 6 diameters long, from the bottom to the top of the neck; their bore must be 1-5th narrower at top than at bottom. The neck S is 1-6th diameter and $\frac{1}{4}$ long. T, a wooden foot or stand, on which the gerbe is fixed. This may be made with a choak or cylinder 4 or 5 inches long to fit the inside of the case, or with a hole in it to put in the gerbe; both these methods will answer the same. Gerbes produce a most brilliant fire, and are very beautiful when a number of them are fixed in the front of a building or a collection of fireworks.

N. B. Gerbes are made by their diameters, and their cases at bottom $\frac{1}{4}$ thick. The method of finding the interior diameter of a gerbe is thus: Supposing you would have the exterior diameter of the case, when made, to be 5 inches, then, by taking 2-4ths for the sides of the case, there will remain $2\frac{1}{2}$ inches for the bore, which will be a very good size. These sort of gerbes should be rammed very hard.

54. Small Gerbes, or white Fountains,

May be made of 4 oz. 8 oz. or 1 lb. cases, puffed and made very strong, of what length you please: but, before you fill them, drive in clay one diameter of their orifice high; and when you have filled a case, bore a vent through the centre of the clay to the composition: the common proportion will do for the vent, which must be primed with a slow charge. These sort of cases, without the clay, may be filled with Chinese fire.

55. To make Pasteboard and Paper Mortars.

Fig. 3. represents a former, and fig. 4. an elm foot, for the mortar. Fig. 5. represents a mortar complete: these mortars are best when made with pasteboard, well puffed before you begin; or, instead of paste, you may use glue. For a cochorn mortar, which is 4 inches 2-5ths diameter, roll the pasteboard on the former 1-6th of its diameter thick; and, when dry, cut one end smooth and even; then nail and glue it on the upper part of the foot: when done, cut off the pasteboard at top, allowing for the length of the mortar $2\frac{1}{2}$ diameters from the mouth of the powder-chamber; then bind the mortar round with a strong cord wetted with glue. U, the bottom part of the foot 1 diameter 2-3ds broad, and 1 diameter high; and that part which goes into the mortar is 2-3ds of its diameter high. W, is a copper chamber for powder, made in a conical form; and is 1-3d of the diameter wide, $1\frac{1}{2}$ of its own diameter long. In the centre of the bottom of this chamber, make a small hole a little way down the foot; this hole must be met by another of the same size, made in the side of the foot, as is shown in the figure. If these holes are made true, and a copper pipe fitted into both, the mortar when loaded will prime itself; for the powder will naturally fall to the bottom of the first hole; then by putting a bit of

quick-match in the side hole, your mortar will be ready to be fired. Air-bal-loons, &c.

Mortars of $5\frac{1}{2}$, eight and ten inches diameter, may be made of paper or pasteboard, by the above method, and in the same proportion; but if larger, it will be best to have them made of brass. N. B. The copper chamber must have a small rim round its edge with holes in it, for screws to make it fast in the foot.

SECT. III. To load Air-balloons, with the number of Stars, Serpents, Snakes, Rain-falls, &c. in Shells of each nature.

56. Mortars to throw Aigrettes, &c.

WHEN you fill your shells, you must first put in the serpents, rains, stars, &c. or whatever they are composed of; then the blowing powder; but the shells must not be quite filled. All those things must be put in at the fuze hole; but marrons being too large to go in at the fuze hole, must be put in before the inside shell be joined. When the shells are loaded, glue and drive in the fuzes very tight. For a cochorn balloon, let the diameter of the fuze hole be $\frac{2}{3}$ ths of an inch; for a royal balloon, which is near $5\frac{1}{2}$ inches diameter, make the fuze hole 1 inch $\frac{1}{4}$ th diameter; for an 8-inch balloon, 1 inch $\frac{1}{3}$ ths; and for a 10-inch balloon, 1 inch $\frac{2}{3}$ ths.

Air-balloons are divided into 4 sorts; viz. first, illuminated balloons; second, balloons of serpents; third, balloons of reports, marrons, and crackers; and fourth, compound balloons. The number and quantities of each article for the different shells are as follow.

Cochorn balloon illuminated.

	oz.
Meal } powder {	1 $\frac{1}{2}$
Corn } powder {	0 $\frac{1}{4}$
Powder for the mortar	2

Length of the fuze composition, $\frac{3}{4}$ ths of an inch; 1 oz. drove or rolled stars, as many as will nearly fill the shell.

Cochorn balloon of serpents.

	oz.
Meal } powder {	1 $\frac{1}{2}$
Corn } powder {	1
Powder for the mortar	2 $\frac{1}{2}$

Length of the fuze composition $1\frac{1}{2}$ ths of an inch: half-ounce cases drove 3 diameters, and bounced 3 diameters, and half-ounce cases drove 2 diameters and bounced 4, of each an equal quantity, and as many of them as will fit in easily placed head to tail.

Cochorn balloons of crackers and reports.

	oz.
Meal } powder {	1 $\frac{1}{2}$
Corn } powder {	0 $\frac{1}{4}$
Powder for the mortar	2

Length of the fuze composition $\frac{3}{4}$ ths of an inch. Reports 4, and crackers of 6 bounces as many as will fill the shell.

Compound cochorn balloons.

	oz. dr.
Meal } powder {	1 4
Corn } powder {	0 12
Powder for the mortar	2 4

Length of the fuze composition $1\frac{1}{2}$ ths of an inch: $\frac{1}{2}$ ounce cases drove $3\frac{1}{2}$ diameters and bounced 2, $1\frac{1}{2}$; $\frac{1}{4}$ ounce cases drove 4 diameters and not bounced 10; blue string stars, 10; rolled stars, as many as will complete the balloon.

Air-bal-
loons, &c.

<i>Royal balloons illuminated.</i>		oz. dr.
Meal } powder {	- - -	1 8
Corn } powder {	- - -	0 12
Powder for the mortar	- - -	3 0

Length of the fuze composition $\frac{3}{8}$ ths of an inch; 2 ounce strung stars, 34; rolled stars, as many as the shell will contain, allowing room for the fuze.

<i>Royal balloons of serpents.</i>		oz. dr.
Meal } powder {	- - -	1 0
Corn } powder {	- - -	1 8
Powder for the mortar	- - -	3 8

Length of the fuze composition 1 inch: 1 ounce-cafes drove $3\frac{1}{2}$ and 4 diameters, and bounced 2, of each an equal quantity, sufficient to load the shell.

<i>Royal balloons with crackers and marrons.</i>		oz. dr.
Meal } powder {	- - -	1 8
Corn } powder {	- - -	1 4
Powder for firing the mortar	- - -	3 0

Length of the fuze composition $1\frac{1}{2}$ ths of an inch; reports 12, and completed with crackers of 8 bounces.

<i>Compound royal balloons.</i>		oz. dr.
Meal } powder {	- - -	1 5
Corn } powder {	- - -	1 6
Powder for the mortar	- - -	3 12

Length of the fuze composition 1 inch: $\frac{1}{2}$ ounce cafes drove and bounced 2 diameters, 8; 2 ounce cafes filled $\frac{3}{8}$ ths of an inch with star composition, and bounced 2 diameters, 8; silver rain-falls, 10; 2 ounce tailed stars, 16; rolled brilliant stars, 30. If this should not be sufficient to load the shell, you may complete it with gold rain-falls.

<i>Eight-inch balloons illuminated.</i>		oz. dr.
Meal } powder {	- - -	2 8
Corn } powder {	- - -	1 4
Powder for the mortar	- - -	9 0

Length of the fuze composition 1 inch $\frac{1}{8}$ th: 2 ounce drove stars, 48; 2 ounce cafes drove with star composition $\frac{3}{8}$ ths of an inch, and bounced 3 diameters, 12; and the balloon completed with 2 ounce drove brilliant stars.

<i>Eight-inch balloons of serpents.</i>		oz. dr.
Meal } powder {	- - -	2 0
Corn } powder {	- - -	2 0
Powder for the mortar	- - -	9 8

Length of the fuze composition 1 inch $\frac{1}{8}$ th: 2 oz. cafes drove $1\frac{1}{2}$ diameter and bounced 2, and 1 ounce cafes drove 2 diameters and bounced $2\frac{1}{2}$, of each an equal quantity sufficient for the shell.

N. B. The star-composition drove in bounced cafes must be managed thus: First, the cafes must be pinched close at one end, then the corn-powder put in for a report, and the cafe pinched again close to the powder, only leaving a small vent for the star composition, which is drove at top, to communicate to the powder at the bounce end.

<i>Compound eight-inch balloons.</i>		oz. dr.
Meal } powder {	- - -	2 8
Corn } powder {	- - -	1 12
Powder for the mortar	- - -	9 4

Length of the fuze composition $\frac{1}{8}$ th: 4 ounce cafes drove with star composition $\frac{3}{8}$ ths of an inch, and bounced 3 diameters, 16; 2 ounce tailed stars, 16; 2 ounce drove brilliant stars, 12; silver rain-falls, 20; 1 ounce drove blue stars, 20; and 1 ounce cafes drove and bounced 2 diameters, as many as will fill the shell.

Another of eight inches.

		oz. dr.	Air-bal- loons, &c.
Meal } powder {	- - -	2 8	
Corn } powder {	- - -	1 12	
Powder for the mortar	- - -	9 4	

Length of the fuze composition 1 inch $\frac{3}{8}$ th: crackers of 6 reports, 10; gold rains, 14; 2 ounce cafes drove with star composition $\frac{3}{8}$ ths of an inch, and bounced 2 diameters, 16; 2 ounce tailed stars, 16; 2 ounce drove brilliant stars, 12; silver rains, 10; 1 ounce drove blue stars, 20; and 1 oz. cafes drove with a brilliant charge 2 diameters and bounced 3, as many as the shell will hold.

<i>A compound ten-inch balloon.</i>		oz. dr.
Meal } powder {	- - -	3 4
Corn } powder {	- - -	2 8
Powder for the mortar	- - -	12 8

Length of the fuze composition $1\frac{1}{2}$ ths of an inch: 1 ounce cafes drove and bounced 3 diameters, 16. Crackers of 8 reports, 12; 4 ounce cafes drove $\frac{1}{2}$ inch with star-composition, and bounced 2 diameters, 14; 2 ounce cafes drove with brilliant fire $1\frac{1}{2}$ diameter, and bounced 2 diameters, 16: 2 ounce drove brilliant stars, 30; 2 ounce drove blue stars, 3; gold rains, 20; silver rains, 20. After all these are put in, fill the remainder of the cafe with tailed and rolled stars.

<i>Ten-inch balloons of three charges.</i>		oz. dr.
Meal } powder {	- - -	3 0
Corn } powder {	- - -	3 2
Powder for the mortar	- - -	13 0

Length of the fuze composition 1 inch. The shell must be loaded with 2 ounce cafes, drove with star composition $\frac{1}{4}$ th of an inch, and on that 1 diameter of gold fire, then bounced 3 diameters; or with 2 ounce cafes first filled 1 diameter with gold fire, then $\frac{1}{4}$ th of an inch with star composition, and on that $1\frac{1}{4}$ th diameter of brilliant fire. These cafes must be well secured at top of the charge, lest they should take fire at both ends: but their necks must be larger than the common proportion.

57. To make Balloon Fuzes.

Fuzes for air-balloons are sometimes turned out of dry beech, with a cup at top to hold the quick-match, as you see in fig. 5. but if made with pasted paper, they will do as well: the diameter of the former for fuzes for cohorn balloons must be $\frac{1}{2}$ an inch; for a royal fuze, $\frac{3}{8}$ ths of an inch; for an 8-inch fuze, $\frac{1}{4}$ ths of an inch; and for a 10-inch fuze, $\frac{3}{8}$ ths of an inch. Having rolled your cafes, pinch and tie them almost close at one end; then drive them down, and let them dry. Before you begin to fill them, mark on the outside of the cafe the length of the charge required, allowing for the thickness of the bottom; and when you have rammed in the composition, take two pieces of quick-match about 6 inches long, and lay one end of each on the charge, and then a little meal-powder, which ram down hard; the loose ends of the match double up into the top of the fuze, and cover it with a paper cap to keep it dry. When you put the shells in the mortars, uncup the fuzes, and pull out the loose ends of the match, and let them hang on the sides of the balloons. The use of the match is, to receive the fire from the powder in the chamber of the mortar, in order to light the fuze: the shell being put in the mortar with the fuze uppermost, and exactly in the centre, sprinkle over it a little meal-powder, and it will be ready to be fired.

Fuzes

Air-bal-
loons, &c.Air-bal-
loons, &c.

Fuzes made of wood must be longer than those of paper, and not bored quite through, but left solid about $\frac{1}{2}$ an inch at bottom; and when you use them, saw them off to a proper length, measuring the charge from the cup at top.

58. *Tourbillons.*

Having filled some cases within about $1\frac{1}{2}$ diameter, drive in a ladleful of clay; then pinch their ends close, and drive them down with a mallet. When done, find the centre of gravity of each case; where you nail and tie a stick, which should be $\frac{1}{2}$ an inch broad at the middle, and run a little narrower to the ends: these sticks must have their ends turned upwards, so that the cases may turn horizontally on their centres: at the opposite sides of the cases, at each end, bore a hole close to the clay with a gimblet, the size of the neck of a common case of the same nature; from these holes draw a line round the case, and at the under part of the case bore a hole with the same gimblet, within $\frac{1}{2}$ diameter of each line towards the centre; then from one hole to the other draw a right line. This line divide into three equal parts; and at X and Y (fig. 6.) bore a hole; then from these holes to the other two lead a quick-match, over which paste a thin paper. Fig. 7. represents a tourbillon as it should lie to be fired, with a leader from one side-hole A to the other B. When you fire tourbillons, lay them on a smooth table, with their sticks downwards, and burn the leader thro' the middle with a port-fire. They should spin three or four seconds on the table before they rise, which is about the time the composition will be burning from the side-holes to those at bottom.

To tourbillons may be fixed reports in this manner: In the centre of the case at top make a small hole, and in the middle of the report make another; then place them together, and tie on the report, and with a single paper secure it from fire: this done, your tourbillon is completed. By this method you may fix on tourbillons small cones of stars, rains, &c. but be careful not to load them too much. One-eighth of an inch will be enough for the thickness of the sticks, and their length equal to that of the cases.

59. *To make Mortars to throw Aigrettes, and to load and fire them.*

Mortars to throw aigrettes are generally made of pasteboard, of the same thickness as balloon mortars, and $2\frac{1}{2}$ diameters long in the inside from the top of the foot: the foot must be made of elm without a chamber, but flat at top, and in the same proportion as those for balloon mortars; these mortars must also be bound round with a cord as before-mentioned: sometimes 8 or 9 of these mortars, of about three or four inches diameter, are bound all together, so as to appear but one: but when they are made for this purpose, the bottom of the foot must be of the same diameter as the mortars, and only $\frac{1}{2}$ diameter high. Your mortars being bound well together, fix them on a heavy solid block of wood. To load these mortars, first put on the inside bottom of each a piece of paper, and on it spread $1\frac{1}{2}$ oz. of meal and corn powder mixed; then tie your serpents up in parcels with quick-match, and put them in the mortar with their mouths downwards; but take care the parcels do not fit too tight in the mortars, and that all the serpents have been well primed with powder wetted with spirit of wine. On the top of the serpents in

each mortar lay some paper or tow; then carry a leader from one mortar to the other all round, and then from all the outside mortars into that in the middle: these leaders must be put between the cases and the sides of the mortar, down to the powder at bottom: in the centre of the middle mortar fix a fire-pump, or brilliant fountain, which must be open at bottom, and long enough to project out of the mouth of the mortar; then paste paper on the tops of all the mortars.

Mortars thus prepared are called a *nest of serpents*, as represented by fig. 8. When you would fire these mortars, light the fire-pump C, which when consumed will communicate to all the mortars at once by means of the leaders. For mortars of 6, 8, or 10 inches diameter, the serpents should be made in 1 and 2 ounce cases 6 or 7 inches long, and fired by a leader brought out of the mouth of the mortar, and turned down the outside, and the end of it covered with paper, to prevent the sparks of the other works from setting it on fire. For a six-inch mortar, let the quantity of powder for firing be 2 oz.; for an 8-inch, $2\frac{1}{4}$ oz.; and for a 10-inch, $3\frac{1}{4}$ oz. Care must be taken in these, as well as small mortars, not to put the serpents in too tight, for fear of bursting the mortars. These mortars may be loaded with stars, crackers, &c.

If the mortars, when loaded, are sent to any distance, or liable to be much moved, the firing powder should be secured from getting amongst the serpents, which would endanger the mortars, as well as hurt their performance. To prevent which, load your mortars thus: First put in the firing powder, and spread it equally about; then cut a round piece of blue touch-paper, equal to the exterior diameter of the mortar, and draw on it a circle equal to the interior diameter of the mortar, and notch it all round as far as that circle; then paste that part which is notched, and put it down the mortar close to the powder, and stick the pasted edge to the mortar: this will keep the powder always smooth at bottom, so that it may be moved or carried anywhere without receiving damage. The large single mortars are called *pots des aigrettes*.

60. *Making, loading, and firing, of Pots des Brins.*

These are formed of pasteboard, and must be rolled pretty thick. They are usually made 3 or 4 inches diameter, and 4 diameters long; and pinched with a neck at one end, like common cases. A number of these are placed on a plank thus: Having fixed on a plank two rows of wooden pegs, cut in the bottom of the plank a groove the whole length under each row of pegs; then, through the centre of each peg, bore a hole down to the groove at bottom, and on every peg fix and glue a pot, whose mouth must fit tight on the peg; through all the holes run a quick-match, one end of which must go into the pot, and the other into the groove, which must have a match laid in it from end to end, and covered with paper, so that when lighted at one end it may discharge the whole almost instantaneously: in all the pots put about 1 oz. of meal and corn powder; then in some put stars, and others rains, snakes, serpents, crackers, &c. when they are all loaded, paste paper over their mouths. Two or three hundred of these pots being fired together make a very pretty show, by affording so great a variety of fires. Fig. 9. is a range of pots des brins, with a leader A, by which they are fired.

61. *Pots des Saucissons,*

Are generally fired out of large mortars without chambers, the same as those for aigrettes, only somewhat stronger. Saucissons are made of 1 and 2 ounce cases, 5 or 6 inches long, and choaked in the same manner as serpents. Half the number which the mortar contains must be drove $1\frac{1}{2}$ diameter with composition, and the other half two diameters, so that when fired they may give two volleys of reports. But if the mortars are very strong, and will bear a sufficient charge to throw the saucissons very high, you may make three volleys of reports, by dividing the number of cases into three parts, and making a difference in the height of the charge. After they are filled, pinch and tie them at top of the charge almost close; only leaving a small vent to communicate the fire to the upper part of the case, which must be filled with corn-powder very near the top; then pinch the end quite close, and tie it: after this is done, bind the case very tight with waxed packthread, from the choak at top of the composition to the end of the case; this will make the case very strong in that part, and cause the report to be very loud. Saucissons should be rolled a little thicker of paper than the common proportion. When they are to be put in the mortar, they must be primed in their mouths, and fired by a case of brilliant fire fixed in their centre.

The charge for these mortars should be $\frac{2}{3}$ th or $\frac{1}{3}$ th more than for *pots des aigrettes* of the same diameter.

SECT. IV. *Different kinds of Rockets, with their Appendages and Combinations.*62. *To fix one Rocket on the top of another.*

WHEN sky-rockets are thus managed, they are called *towering rockets*, on account of their mounting so very high. Towering rockets are made after this manner: Fix on a pound-rocket a head without a collar; then take a four ounce rocket, which may be headed or bounced, and rub the mouth of it with meal-powder wetted with spirit of wine: when done, put it in the head of the large rocket with its mouth downwards; but before you put it in, stick a bit of quick-match in the hole of the clay of the pound-rocket, which match should be long enough to go a little way up the bore of the small rocket, to fire it when the large is burnt out, the 4 ounce rocket being too small to fill the head of the other, roll round it as much tow as will make it stand upright in the centre of the head: the rocket being thus fixed, paste a single paper round the opening of the top of the head of the large rocket. The large rocket must have only half a diameter of charge rammed above the piercer; for, if filled to the usual height, it would turn before the small one takes fire, and entirely destroy the intended effect: when one rocket is headed with another, there will be no occasion for any blowing powder; for the force with which it sets off will be sufficient to disengage it from the head of the first fired rocket. The sticks for these rockets must be a little longer than for those headed with stars, rains, &c.

63. *Caduceus Rockets,*

In rising, form two spiral lines, or double worm, by reason of their being placed obliquely, one opposite

the other; and their counterpoise in their centre, which Rockets, causes them to rise in a vertical direction. Rockets for this purpose must have their ends choaked close, without either head or bounce, for a weight at top would be a great obstruction to their mounting; though I have known them sometimes to be bounced, but then they did not rise so high as those that were not; nor do any caduceus rockets ascend so high as single, because of their serpentine motion, and likewise the resistance of air, which is much greater than two rockets of the same size would meet with if fired singly.

By 2d fig. 9. you see the method of fixing these rockets: the sticks for this purpose must have all their sides alike, which sides should be equal to the breadth of a stick proper for a sky-rocket of the same weight as those you intend to use, and to taper downwards as usual, long enough to balance them, one length of a rocket from the cross stick; which must be placed from the large stick 6 diameters of one of the rockets, and its length 7 diameters; so that each rocket, when tied on, may form with the large stick an angle of 60 degrees. In tying on the rockets, place their heads on the opposite sides of the cross stick, and their ends on the opposite sides of the long stick; then carry a leader from the mouth of one into that of the other. When these rockets are to be fired, suspend them between two hooks or nails, then burn the leader through the middle, and both will take fire at the same time. Rockets of 1 lb. are a good size for this use.

64. *Honorary Rockets,*

Are the same as sky-rockets, except that they carry no head nor report, but are closed at top, on which is fixed a cone; then on the case, close to the top of the stick, you tie on a 2 ounce case, about 5 or 6 inches long, filled with a strong charge, and pinched close at both ends; then in the reverse sides, at each end, bore a hole in the same manner as in tourbillons; from each hole carry a leader into the top of the rocket. When the rocket is fired, and arrived to its proper height, it will give fire to the case at top; which will cause both rocket and stick to spin very fast in their return, and represent a worm of fire descending to the ground.

There is another method of placing the small case, which is by letting the stick rise a little above the top of the rocket, and tying the case to it, so as to rest on the rocket: these rockets have no cones.

There is also a third method by which they are managed, which is thus: In the top of a rocket fix a piece of wood, in which drive a small iron spindle; then make a hole in the middle of the small case, through which put the spindle: then fix on the top of it a nut, to keep the case from falling off; when this is done, the case will turn very fast, without the rocket: but this method does not answer so well as either of the former.

Fig. 10. is the honorary rocket complete. The best sized rockets for this purpose are those of 1 lb.

65. *To divide the tail of a Sky-rocket so as to form an Arch when ascending.*

Having some rockets made, and headed according to fancy, and tied on their sticks; get some sheet tin, and cut it into round pieces about 3 or 4 inches diameter; then on the stick of each rocket, under the mouth of the case, fix one of these pieces of tin 16 inches from the rocket's neck, and support it by a wooden bracket,

Rockets, &c. as strong as possible: the use of this is, that when the rocket is ascending the fire will play with great force on the tin, which will divide the tail in such a manner that it will form an arch as it mounts, and will have a very good effect when well managed: if there is a short piece of port-fire, of a strong charge, tied to the end of the stick, it will make a great addition; but this must be lighted before you fire the rocket.

66. *To make several Sky-rockets rise in the same direction, and equally distant from each other.*

Take six, or any number of sky-rockets, of what size you please, then cut some strong packthread into pieces of 3 or 4 yards long, and tie each end of these pieces to a rocket in this manner: Having tied one end of your packthread round the body of one rocket, and the other end to another, take a second piece of packthread and make one end of it fast to one of the rockets already tied, and the other end to a third rocket, so that all the rockets, except the two outside, will be fastened to two pieces of packthread: the length of thread from one rocket to the other may be what the maker pleases; but the rockets must be all of a size, and their heads filled with the same weight of stars, rains, &c.

Having thus done, fix in the mouth of each rocket a leader of the same length; and when you are going to fire them, hang them almost close; then tie the ends of the leaders together, and prime them: this prime being fired, all the rockets will mount at the same time, and divide as far as the strings will allow; which division they will keep, provided they are all rammed alike, and well made. They are called by some *chained rockets*.

67. *Signal Sky-rockets*

Are made of several kinds, according to the different signals intended to be given; but in artificial fireworks, two sorts are only used, which are one with reports and the other without; but those for the use of the navy and army are headed with stars, serpents, &c.—Rockets which are to be bounced must have their cases made $1\frac{1}{2}$ or 2 diameters longer than the common proportion; and after they are filled, drive in a double quantity of clay, then bounce and pinch them after the usual manner, and fix on each a cap.

Signal sky-rockets without bounces, are only sky-rockets closed and capped: these are very light, therefore do not require such heavy sticks as those with loaded heads; for which reason you may cut one length of the rocket off the stick, or else make them thinner.

Signal rockets with reports are fired in small flights; and often both these, and those without reports, are used for a signal to begin firing a collection of works.

68. *To fix a Sky-rocket with its Stick on the top of another.*

Rockets thus managed make a pretty appearance, by reason of a fresh tail being seen when the second rocket takes fire, which will mount to a great height. The method of preparing these rockets is thus: Having filled a two-pounder, which must be filled only half a diameter above the piercer, and its head not more than 10 or 12 stars; the stick of this rocket must be made a little thicker than common; and when made, cut it in half the flat way, and in each half make a groove, so that when the two halves are joined, the hollow made by the grooves may be large enough to hold the stick

of a half-pound rocket; which rocket make and head Rockets, as usual: put the stick of this rocket into the hollow of the large one, so far that the mouth of the rocket may rest on the head of the two-pounder; from whose head carry a leader into the mouth of the small rocket; which being done, your rockets will be ready for firing.

2d 68. *To fix two or more Sky-rockets on one Stick.*

Two, three, or six sky-rockets, fixed on one stick, and fired together, make a grand and beautiful appearance; for the tails of all will seem but as one of an immense size, and the breaking of so many heads at once will resemble the bursting of an air-balloon. The management of this device requires a skilful hand; but if the following instructions be well observed, even by those who have not made a great progress in this art, there will be no doubt of the rockets having the desired effect.

Rockets for this purpose must be made with the greatest exactness, all rammed by the same hand, in the same mould, and out of the same proportion of composition; and after they are filled and headed, must all be of the same weight. The stick must also be well made (and proportioned) to the following directions: first, supposing your rockets to be $\frac{1}{2}$ pounders, whose sticks are 6 feet 6 inches long, then if 2, 3, or 6 of these are to be fixed on 1 stick, let the length of it be 9 feet 9 inches; then cut the top of it into as many sides as there are rockets, and let the length of each side be equal to the length of 1 of the rockets without its head; and in each side cut a groove (as usual); then from the grooves plane it round, down to the bottom, where its thickness must be equal to half the top of the round part. As their thickness cannot be exactly ascertained, we shall give a rule which generally answers for any number of rockets above two: the rule is this; that the stick at top must be thick enough, when the grooves are cut, for all the rockets to lie, without pressing each other, though as near as possible.

When only 2 rockets are to be fixed on one stick, let the length of the stick be the last given proportion, but shaped after the common method, and the breadth and thickness double the usual dimensions. The point of poise must be in the usual place (let the number of rockets be what they will): if sticks made by the above directions should be too heavy, plane them thinner; and if too light, make them thicker; but always make them of the same length.

When more than two rockets are tied on one stick, there will be some danger of their flying up without the stick, unless the following precaution is taken: For cases being placed on all sides, there can be no notches for the cord which ties on the rockets to lie in; therefore, instead of notches, drive a small nail in each side of the stick, between the necks of the cases: and let the cord, which goes round their necks, be brought close under the nails; by this means the rockets will be as secure as when tied on singly. Your rockets being thus fixed, carry a quick-match, without a pipe, from the mouth of one rocket to the other; this match being lighted will give fire to all at once.

Though the directions already given may be sufficient for these rockets, we shall here add an improvement on a very essential part of this device, which is, that of hanging the rockets to be fired; for before the following

Rockets,
&c.

following method was hit upon, many essays proved unsuccessful. Instead, therefore, of the old and common manner of hanging them on nails or hooks, make use of this contrivance: Have a ring made of strong iron wire, large enough for the stick to go in as far as the mouths of the rockets; then let this ring be supported by a small iron, at some distance from the post or stand to which it is fixed; then have another ring, fit to receive and guide the small end of the stick. Rockets thus suspended will have nothing to obstruct their fire; but when they are hung on nails or hooks, in such a manner that some of their mouths are against or upon a rail, there can be no certainty of their rising in a vertical direction.

69. To fire Sky-rockets without Sticks.

You must have a stand, of a block of wood, a foot diameter, and make the bottom flat, so that it may stand steady: in the centre of the top of this block draw a circle $2\frac{1}{2}$ inches diameter, and divide the circumference of it into three equal parts; then take 3 pieces of thick iron wire, each about 3 feet long, and drive them into the block, 1 at each point made on the circle; when these wires are drove in deep enough to hold them fast and upright, so that the distance from one to the other is the same at top as at bottom, the stand is complete.

The stand being thus made, prepare your rockets thus: Take some common sky-rockets, of any size, and head them as you please; then get some balls of lead, and tie to each a small wire 2 or $2\frac{1}{2}$ feet long, and the other end of each wire tie to the neck of a rocket. These balls answer the purpose of sticks when made of a proper weight, which is about 2-3ds the weight of the rocket; but when they are of a proper size, they will balance the rocket in the same manner as a stick, at the usual point of poise. To fire these, hang them, one at a time, between the tops of the wires, letting their heads rest on the point of the wires, and the balls hang down between them: if the wires should be too wide for the rockets, press them together till they fit; and if too close, force them open; the wires for this purpose must be softened, so as not to have any spring, or they will not keep their position when pressed close or opened.

70. Rain-falls and Stars for Sky-rockets, Double and Single.

Gold and silver rain compositions are drove in cases that are pinched quite close at one end: if you roll them dry, 4 or 5 rounds of paper will be strong enough; but if they are pasted, 3 rounds will do; and the thin sort of cartridge-paper is best for those small cases, which in rolling you must not turn down the inside edge as in other cases, for a double edge would be too thick for so small a bore. The moulds for rain-falls should be made of brass, and turned very smooth in the inside; or the cases, which are so very thin, would tear in coming out; for the charge must be drove in tight; and the better the case fits the mould, the more driving it will bear. These moulds have no nipple, but instead thereof they are made flat. As it would be very tedious and troublesome to shake the composition out of such small ladles as are used for these cases, it will be necessary to have a funnel made of thin tin, to fit on the top of the case, by the help of which you may fill them very fast. For fine rain-

falls for 4 oz. rockets, let the diameter of the former be $\frac{2}{16}$ ths of an inch, and the length of the case 2 inches; for 8 oz. rockets, $\frac{4}{16}$ ths and 2 diameters of the rocket long; for 1 lb. rockets, $\frac{5}{16}$ ths, and 2 diameters of the rocket long; for 2 lb. rockets, $\frac{5}{16}$ ths, and $3\frac{1}{2}$ inches long; for 4 lb. rockets, $\frac{6}{16}$ ths, and $4\frac{1}{2}$ inches long; and for 6-pounders, $\frac{7}{16}$ ths diameter, and 5 inches long.

Of double rain-falls there are two sorts. For example, some appear first like a star, and then as rain; and some appear first as rain, and then like a star. When you would have stars first, you must fill the cases, within $\frac{1}{4}$ inch of the top, with rain-composition, and the remainder with star-composition; but when you intend the rain should be first, drive the case $\frac{1}{2}$ an inch with star-composition, and the rest with rain. By this method may be made many changes of fire; for in large rockets you may make them first burn as stars, then rain, and again as stars; or they may first show rain, then stars, and finish with a report; but when they are thus managed, cut open the first rammed end, after they are filled and bounced, at which place prime them. The star-composition for this purpose must be a little stronger than for rolled stars.

Strung stars. First take some thin paper, and cut it into pieces of $1\frac{1}{2}$ inch square, or thereabouts; then on each piece lay as much dry star-composition as you think the paper will easily contain; then twist up the paper as tight as you can; when done, rub some paste on your hands, and roll the stars between them; then set them to dry: your stars being thus made, get some flax or fine tow, and roll a little of it over each star; then paste your hands and roll the stars as before, and set them again to dry; when they are quite dry, with a piercer make a hole through the middle of each, into which run a cotton quick-match, long-enough to hold 10 or 12 stars at 3 or 4 inches distance: but any number of stars may be strung together by joining the match.

Tailed stars. These are called *tailed stars*, because there are a great number of sparks issue from them, which represent a tail like that of a comet. Of these there are two sorts; which are *rolled*, and *drove*: when rolled, they must be moistened with a liquor made of half a pint of spirit of wine and half a gill of thin size, of this as much as will wet the composition enough to make it roll easy; when they are rolled, sift meal-powder over them, and set them to dry.

When tailed stars are drove, the composition must be moistened with spirit of wine only, and not made so wet as for rolling: 1 and 2 oz. cases, rolled dry, are best for this purpose; and when they are filled, unroll the case within 3 or 4 rounds of the charge, and all that you unroll cut off; then paste down the loose edge: 2 or 3 days after the cases are filled, cut them in pieces 5 or 6-8ths of an inch in length: then melt some wax, and dip one end of each piece into it, so as to cover the composition: the other end must be rubbed with meal-powder wetted with spirit of wine.

Drove stars. Cases for drove stars are rolled with paste, but are made very thin of paper. Before you begin to fill them, damp the composition with spirit of wine that has had some camphor dissolved in it: you may ram them indifferently hard, so that you do not break or sack the case; to prevent which, they should

Rockets,
&c.Rockets,
&c.

should fit tight in the mould. They are drove in cases of several sizes, from 8 drams to 4 oz. When they are filled in $\frac{1}{2}$ oz. cases, cut them in pieces of $\frac{1}{2}$ of an inch long; if 1 oz. cases, cut them in pieces of 1 inch; if 2 oz. cases, cut them in pieces of $1\frac{1}{4}$ inch long; and if 4 oz. cases, cut them in pieces of $1\frac{1}{2}$ inch long: having cut your stars of a proper size, prime both ends with wet meal-powder. These stars are seldom put in rockets, they being chiefly intended for air-balloons, and drove in cases, to prevent the composition from being broke by the force of the blowing powder in the shell.

Rolling stars are commonly made about the size of a musket-ball; though they are rolled of several sizes, from the bigness of a pistol-ball to 1 inch diameter; and sometimes very small, but are then called *sparks*. Great care must be taken in making stars, first, that the several ingredients are reduced to a fine powder; secondly, that the composition is well worked and mixed. Before you begin to roll, take about a pound of composition, and wet it with the following liquid, enough to make it stick together and roll easy: Spirit of wine 1 quart, in which dissolve $\frac{1}{4}$ of an ounce of isinglass. If a great quantity of composition be wetted at once, the spirit will evaporate, and leave it dry, before you can roll it into stars: having rolled up one proportion, shake the stars in meal-powder, and set them to dry, which they will do in 3 or 4 days; but if you should want them for immediate use, dry them in an earthen pan over a slow heat, or in an oven. It is very difficult to make the stars all of an equal size when the composition is taken up promiscuously with the fingers; but by the following method they may be made very exact: When the mixture is moistened properly, roll it on a flat smooth stone, and cut it into square pieces, making each square large enough for the stars you intend. There is another method used by some to make stars, which is by rolling the composition in long pieces, and then cutting off the star, so that each star will be of a cylindrical form: but this method is not so good as the former; for, to make the composition roll this way, it must be made very wet, which makes the stars heavy, as well as weakens them. All stars must be kept as much from air as possible, otherwise they will grow weak and bad.

71. *Scrolls for Sky-rockets.*

Cases for scrolls should be made 4 or 5 inches in length, and their interior diameter $\frac{3}{8}$ ths of an inch: one end of these cases must be pinched quite close, before you begin to fill; and when filled, close the other end: then in the opposite sides make a small hole at each end, to the composition, in the same manner as in tourbillons; and prime them with wet meal-powder. You may put in the head of a rocket as many of these cases as it will contain: being fired they turn very quick in the air, and form a scroll or spiral line. They are generally filled with a strong charge, as that of serpents or brilliant fire.

72. *Swarmers, or small Rockets.*

Rockets that go under the denomination of *swarmers*, are those from 2 oz. downwards. These rockets are fired sometimes in flights, and in large water-works, &c. Swarmers of 1 and 2 oz. are bored, and made in the same manner as large rockets, except that,

when headed, their heads must be put on without a collar: the number of strokes for driving 1 oz. must be 8, and for 2 oz. 12.

All rockets under 1 oz. are not bored, but must be filled to the usual height with composition, which generally consists of fine meal-powder 4 oz. and charcoal or steel-dust 2 drams: the number of strokes for ramming these small swarmers is not material, provided they are rammed true, and moderately hard. The necks of unbored rockets must be in the same proportion as in common cases.

73. *Stands for Sky-rockets.*

Care must be taken, in placing the rockets when they are to be fired, to give them a vertical direction at their first setting out; which may be managed thus: Have two rails of wood, of any length, supported at each end by a perpendicular leg, so that the rails be horizontal, and let the distance from one to the other be almost equal to the length of the sticks of the rockets intended to be fired; then in the front of the top rail drive square hooks at 8 inches distance, with their points turning sidewise, so that when the rockets are hung on them, the points will be before the sticks and keep them from falling or being blown off by the wind: in the front of the rail at bottom must be staples, drove perpendicular under the hooks at top; through these staples put the small ends of the rocket-sticks. Rockets are fired by applying a lighted port-fire to their mouths.

N. B. When sky-rockets are made to perfection, and fired, they will stand 2 or 3 seconds on the hook before they rise, and then mount up briskly, with a steady motion, carrying a large tail from the ground all the way up, and just as they turn break and disperse the stars.

74. *Girandole Chests for Flights of Rockets.*

These are generally composed of four sides, of equal dimensions; but may be made of any diameter, according to the number of rockets designed to be fired; its height must be in proportion to the rockets, but must always be a little higher than the rockets with their sticks. When the sides are joined, fix in the top, as far down the chest as the length of one of the rockets with its cap on. In this top, make as many square or round holes to receive the rocket-sticks, as you intend to have rockets; but let the distance between them be sufficient for the rockets to stand without touching one another; then from one hole to another cut a groove large enough for a quick-match to lie in: the top being thus fixed, put in the bottom, at about $1\frac{1}{2}$ foot distance from the bottom of the chest; in this bottom must be as many holes as in the top, and all to correspond; but these holes need not be so large as those in the top.

To prepare your chest, you must lay a quick-match, in all the grooves, from hole to hole; then take some sky-rockets, and rub them in the mouth with wet meal-powder, and put a bit of match up the cavity of each; which match must be long enough to hang a little below the mouth of the rocket. Your rockets and chest being prepared according to the above directions, put the sticks of the rockets through the holes in the top and bottom of the chest, so that their mouths may rest on the quick-match in the grooves: by which all the rockets will be fired at once; for by giving fire to any

part of the match, it will communicate to all the rockets in an instant. As it would be rather troublesome to direct the sticks from the top to the proper holes in the bottom, it will be necessary to have a small door in one of the sides, which, when opened, you may see how to place the sticks. Flights of rockets being seldom set off at the beginning of any fire-works, they are in danger of being fired by the sparks from wheels, &c. therefore, to preserve them, a cover should be made to fit on the chest, and the door in the side kept shut.

75. *Serpents or Snakes for Pots of Aigrettes, small Mortars, Sky-rockets, &c.*

Serpents for this use are made from $2\frac{1}{2}$ inches to 7 inches long, and their formers from $\frac{3}{16}$ ths to $\frac{5}{8}$ ths of an inch diameter; but the diameter of the cases must always be equal to 2 diameters of the former. They are rolled and choaked like other cases, and filled with composition from $\frac{5}{8}$ ths of an inch to $1\frac{1}{2}$ inch high, according to the size of the mortars or rockets they are designed for; and the remainder of the cases bounced with corn-powder, and afterwards their ends pinched and tied close: before they are used, their mouths must be primed with wet meal-powder.

76. *Leaders, or Pipes of Communication.*

The best paper for leaders is elephant; which you cut into long slips 2 or 3 inches broad, so that they may go 3 or 4 times round the former, but not more: when they are very thick, they are too strong for the paper which fastens them to the works, and will sometimes fly off without leading the fire. The formers for these leaders are made from 2 to $\frac{6}{16}$ ths of an inch diameter; but $\frac{4}{16}$ ths is the size generally made use of. The formers are made of smooth brass wire: when you use them, rub them over with grease, or keep them wet with paste, to prevent their sticking to the paper, which must be pasted all over. In rolling of pipes, make use of a rolling-board, but use it lightly: having rolled a pipe, draw out the former with one hand, holding the pipe as light as possible with the other; for if it presses against the former, it will stick and tear the paper.

N. B. Make your leaders of different lengths, or in clothing of works you will cut a great many to waste. Leaders for marron batteries must be made of strong cartridge paper.

77. *Crackers.*

Cut some cartridge paper into pieces $3\frac{1}{2}$ inches broad, and one foot long; one edge of each fold down lengthwise about $\frac{1}{4}$ of an inch broad; then fold the double edge down $\frac{1}{4}$ of an inch, and turn the single edge back half over the double fold; then open it, and lay all along the channel, which is formed by the folding of the paper, some meal-powder; then fold it over and over till all the paper is doubled up, rubbing it down every turn; this done, bend it backwards and forwards, $2\frac{1}{2}$ inches, or thereabouts, at a time, as oft as the paper will allow; then hold all these folds flat and close, and with a small pinching cord give one turn round the middle of the cracker, and pinch it close; then bind it with a packthread as tight as you can; then, in the place where it was pinched, prime one end of it, and cap it with touch-paper. When these crackers are fired, they will give a report at every turn of the paper: if you would have a great number of bounces,

you must cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you must have a piece of wood with a groove in it, deep enough to let in half the cracker; this will hold it straight while it is pinching. Fig. 12. represents a cracker complete.

78. *Single Reports.*

Cases for reports are generally rolled on one and two oz. formers, and seldom made larger but on particular occasions; they are made from two to four inches long, and very thick of paper. Having rolled a case, pinch one end quite close, and drive it down: then fill the case with corn-powder, only leaving room to pinch it at top; but before you pinch it, put in a piece of paper at top of the powder. Reports are fired by a vent, bored in the middle, or at one end, just as required.

79. *Marrons.*

Formers for marrons are from $\frac{1}{4}$ of an inch to $1\frac{1}{2}$ diameter. Cut the paper for the cases twice the diameter of the former broad, and long enough to go three times round: when you have rolled a case, paste down the edge and tie one end close; then with the former drive it down to take away the wrinkles, and make it flat at bottom; then fill the case with corn-powder one diameter and $\frac{1}{4}$ high, and fold down the rest of the case tight on the powder. The marron being thus made, wax some strong pack-thread with shoemakers wax; this thread wind up in a ball, then unwind two or three yards of it, and that part which is near the ball make fast to a hook; then take a marron, and stand as far from the hook as the pack-thread will reach, and wind it lengthwise round the marron as close as you can, till it will hold no more that way; then turn it, and wind the packthread on the short way, then lengthwise again, and so on till the paper is all covered; then make fast the end of the packthread, and beat down both ends of the marron to bring it in shape. The method of firing marrons is by making a hole at one end with an awl, and putting in a piece of quick-match; then take a piece of strong paper, in which wrap up the marron with two leaders, which must be put down to the vent, and the paper tied tight round them with small twine: these leaders are bent on each side, and their loose ends tied to other marrons, and are nailed in the middle to the rail of the stand, as in fig. 13. The use of winding the packthread in a ball is, that you may let it out as you want it, according to the quantity the marron may require; and that it may not be tied in knots, which would spoil the marron.

80. *Marron Batteries.*

If well managed, will keep time to a march, or a slow piece of music. Marron batteries are made of several stands, with a number of cross rails for the marrons; which are regulated by leaders, by cutting them of different lengths, and nailing them tight, or loose, according to the time of the music. In marron batteries you must use the large and small marrons, and the nails for the pipes must have flat heads.

81. *Line Rockets.*

Are made and drove as the sky-rockets, but have no heads, and the cases must be cut close to the clay: they are sometimes made with six or seven changes, but in general not more than four or five. The method of managing those rockets is thus: First, have a piece of light wood, the length of one of the rockets, turned round

Rockets,
&c.Rockets,
&c.

round about $2\frac{1}{2}$ inches diameter, with a hole through the middle lengthwise, large enough for the line to go easily through: if you design four changes, have four grooves cut in the swivel, one opposite the other, to lay the rockets in.

The mouths of the rockets being rubbed with wet meal-powder, lay them in the grooves head to tail, and tie them fast; from the tail of the first rocket carry a leader to the mouth of the second, and from the second to the third, and so on to as many as there are on the swivel, making every leader very secure; but in fixing these pipes, take care that the quick-match does not enter the bores of the rockets: the rockets being fixed on the swivel and ready to be fired, have a line 100 yards long, stretched and fixed up tight, at any height from the ground; but be sure to place it horizontally: this length of line will do for $\frac{1}{2}$ lb. rockets; but if larger, the line must be longer. Before you put up the line, put one end of it through the swivel; and when you fire the line rocket, let the mouth of that rocket which you fire first face that end of the line where you stand; then the first rocket will carry the rest to the other end of the line, and the second will bring them back; and so they will run out and in according to the number of rockets: at each end of the line there must be a piece of flat wood for the rocket to strike against, or its force will cut the line. Let the line be well soaped, and the hole in the swivel very smooth.

82. Different Decorations for Line Rockets.

To line rockets may be fixed great variety of figures, such as flying dragons, Mercuries, ships, &c. Or they may be made to run on the line like a wheel; which is done in this manner. Have a flat swivel made very exact, and on it tie two rockets obliquely, one on each side, which will make it turn round all the way it goes, and form a circle of fire; the charge for these rockets should be a little weaker than common. If you would shew two dragons fighting, get two swivels made square, and on each tie three rockets together on the under side; then have two flying dragons made of tin, and fix one of them on the top of each swivel, so as to stand upright; in the mouth of each dragon put a small case of common fire, and another at the end of the tail; you may put two or three port-fires, of a strong charge, on one side of their bodies, to shew them. This done, put them on the line, one at each end; but let there be a swivel in the middle of the line to keep the dragons from striking together: before you fire the rockets, light the cases on the dragons; and if care be taken in firing both at the same time, they will meet in the middle of the line, and seem to fight. Then they will run back and return with great violence; which will have a very pleasing effect. The line for these rockets must be very long, or they will strike too hard together.

83. Chinese Flyers.

Cases for flyers may be made of different sizes, from one to eight ounces: they must be made thick of paper; and eight interior diameters long; they are rolled in the same manner as tourbillons, with a straight pasted edge, and pinched close at one end. The method of filling them is, the case being put in a mould, whose cylinder, or foot, must be flat at top without a nipple, fill it within $\frac{1}{2}$ a diameter of the middle; then ram in $\frac{1}{2}$ a diameter of clay, on that as much composition as

before, on which drive $\frac{1}{2}$ a diameter of clay; then pinch the case close, and drive it down flat: after this is done, bore a hole exactly through the centre of the clay in the middle; then in the opposite sides, at both ends, make a vent; and in that side you intend to fire first make a small hole to the composition near the clay in the middle, from which carry a quick-match, covered with a single paper, to the vent at the other end; then, when the charge is burnt on one side, it will, by means of the quick-match, communicate to the charge on the other (which may be of a different sort). The flyers being thus made, put an iron pin, that must be fixed in the work on which they are to be fired, and on which they are to run, through the hole in the middle; on the end of this pin must be a nut to keep the flyer from running off. If you would have them turn back again after they are burnt, make both the vents at the ends on the same side, which will alter its course the contrary way.

84. Table Rockets,

Are designed merely to show the truth of driving, and the judgment of a fire-worker, they having no other effect, when fired, than spinning round in the same place where they begin, till they are burnt out, and showing nothing more than an horizontal circle of fire.

The method of making these rockets is—Have a cone turned out of hard wood $2\frac{1}{2}$ inches diameter, and as much high; round the base of it draw a line; on this line fix four spokes, two inches long each, so as to stand one opposite the other; then fill four nine-inch one lb cases with any strong composition, within two inches of the top: these cases are made like tourbillons, and must be rammed with the greatest exactness.

Your rockets being filled, fix their open ends on the short spokes; then in the side of each case bore a hole near the clay; all these holes, or vents, must be so made that the fire of each case may act the same way; from these vents carry leaders to the top of the cone, and tie them together. When you would fire the rockets, set them on a smooth table, and light the leaders in the middle, and all the cases will fire together (see fig. 14.) and spin on the point of the cone.

These rockets may be made to rise like tourbillons, by making the cases shorter, and boring four holes in the under side of each at equal distances: this being done, they are called *double tourbillons*.

Note, All the vents in the under side of the cases must be lighted at once; and the sharp point of the cone cut off, at which place make it spherical.

Plate
CCCCXIX.

SECT. V. Of Wheels and other Works.

85. Single Vertical Wheels.

THERE are different sorts of vertical wheels; some having their fells of a circular form, others of an hexagon, octagon, or decagon form, or any number of sides, according to the length of the cases you design for the wheel: your spokes being fixed in the nave, nail slips of tin, with their edges turned up, so as to form grooves for the cases to lie in, from the end of one spoke to another; then tie your cases in the grooves head to tail, in the same manner as those on the horizontal water-wheel, so that the cases successively taking fire from one another, will keep the wheel in an equal rotation. Two of these wheels are very oft fired together, one on each

Of Wheels,
&c.

side of a building; and both lighted at the same time, and all the cafes filled alike, to make them keep time together; which they will do if made by the following directions. In all the cafes of both wheels, except the first, on each wheel drive two or three ladles full of slow fire, in any part of the cafes; but be careful to ram the same quantity in each cafe, and in the end of one of the cafes, on each wheel, you may ram one ladlefull of dead-fire composition, which must be very lightly drove; you may also make many changes of fire by this method.

Let the hole in the nave of the wheel be lined with brass, and made to turn on a smooth iron spindle. On the end of this spindle let there be a nut, to screw off and on; when you have put the wheel on the spindle, screw on the nut, which will keep the wheel from flying off. Let the mouth of the first cafe be a little raised. See fig. 15. Vertical wheels are made from 10 inches to 3 feet diameter, and the size of the cafes must differ accordingly; 4-oz. cafes will do for wheels of 14 or 16 inches diameter, which is the proportion generally used. The best wood for wheels of all sorts is a light and dry beech.

86. Horizontal Wheels,

Are best when their fells are made circular; in the middle of the top of the nave must be a pintle, turned out of the same piece as the nave, two inches long, and equal in diameter to the bore of one of the cafes of the wheel: there must be a hole bored up the centre of the nave, within half an inch of the top of the pintle. The wheel being made, nail at the end of each spoke (of which there should be six or eight) a piece of wood, with a groove cut in it to receive the cafe. Fix these pieces in such a manner that half the cafes may incline upwards and half downwards, and that, when they are tied on, their heads and tails may come very near together; from the tail of one cafe to the mouth of the other carry a leader, which secure with pasted paper. Besides these pipes, it will be necessary to put a little meal-powder inside the pasted paper, to blow off the pipe, that there may be no obstruction to the fire from the cafes. By means of these pipes the cafe will successively take fire, burning one upwards and the other downwards. On the pintle fix a cafe of the same sort as those on the wheel; this cafe must be fired by a leader from the mouth of the last cafe on the wheel, which cafe must play downwards: instead of a common cafe in the middle, you may put a cafe of Chinese fire, long enough to burn as long as two or three of the cafes on the wheel.

Horizontal wheels are oft fired two at a time, and made to keep time like vertical wheels, only they are made without any slow or dead fire; 10 or 12 inches will be enough for the diameter of wheels with six spokes. Fig. 16. represents a wheel on fire, with the first cafe burning.

87. Spiral Wheels,

Are only double horizontal wheels, and made thus: The nave must be about 6 inches long, and somewhat thicker than the single sort; instead of the pintle at top, make a hole for the cafe to be fixed in, and two sets of spokes, one set near the top of the nave, and the other near the bottom. At the end of each spoke cut a groove wherein you tie the cafes, there being no fell; the spokes should not be more than $3\frac{1}{2}$ inches long from

the nave, so that the wheel may not be more than 8 or 9 inches diameter; the cafes are placed in such a manner, that those at top play down, and those at bottom play up, but let the third or fourth cafe play horizontally. The cafe in the middle may begin with any of the others you please: 6 spokes will be enough for each set, so that the wheel may consist of 12 cafes, besides that on the top: the cafes 6 inches each.

88. Plural Wheels,

Are made to turn horizontally, and to consist of three sets of spokes, placed 6 at top, 6 at bottom, and 4 in the middle, which must be a little shorter than the rest: let the diameter of the wheel be 10 inches; the cafes must be tied on the ends of the spokes in grooves cut on purpose, or in pieces of wood nailed on the ends of the spokes, with grooves cut in them as usual: in clothing these wheels, make the upper set of cafes play obliquely downwards, the bottom set obliquely upwards, and the middle set horizontally. In placing the leaders, you must order it so that the cafes may burn thus, viz. first up, then down, then horizontal, and so on with the rest. But another change may be made, by driving in the end of the 8th cafe two or three ladlefuls of slow fire, to burn till the wheel has stopped its course; then let the other cafes be fixed the contrary way, which will make the wheel run back again: for the cafe at top you may put a small gerbe; and let the cafes on the spokes be short, and filled with a strong brilliant charge.

89. Illuminated Spiral Wheel.

First have a circular horizontal wheel made two feet diameter, with a hole quite through the nave; then take three thin pieces of deal, three feet long each, and $\frac{1}{4}$ of an inch broad each: one end of each of these pieces nail to the fell of the wheel, at an equal distance from one another, and the other end nail to a block with a hole in its bottom, which must be perpendicular with that in the block of the wheel, but not so large. The wheel being thus made, have a hoop planed down very thin and flat; then nail one end of it to the fell of the wheel, and wind it round the three sticks in a spiral line from the wheel to the block at top: on the top of this block fix a cafe of Chinese fire; on the wheel you may place any number of cafes, which must incline downwards, and burn two at a time. If the wheel should consist of 10 cafes, you may let the illuminations and Chinese fire begin with the second cafes. The spindle for this wheel must be a little longer than the cone, and made very smooth at top, on which the upper block is to turn, and the whole weight of the wheel to rest. See fig. 17.

90. Double Spiral Wheel.

For this wheel the block, or nave, must be as long as the height of the worms, or spiral lines, but must be made very thin, and as light as possible. In this block must be fixed several spokes, which must diminish in length, from the wheel to the top, so as not to exceed the surface of a cone of the same height. To the ends of these spokes nail the worms, which must cross each other several times: these worms clothe with illuminations, the same as those on the single wheels; but the horizontal wheel you may clothe as you like. At top of the worm place a cafe of spur-fire, or an amber light. See fig. 18. This figure is shown without leaders, to prevent a confusion of lines.

91. Balloon Wheels,

Are made to turn horizontally: they must be made 2 feet

Of Wheels,
&c.

Of Wheels, &c. 2 feet diameter, without any spokes; and very strong, with any number of sides. On the top of a wheel range and fix in pots, 3 inches diameter and 7 inches high each, as many of these as there are cafes on the wheel; near the bottom of each pot make a small vent; into each of these vents carry a leader from the tail of each cafe; some of the pots load with flars, and some with serpents, crackers, &c. As the wheels turn, the pots will successively be fired, and throw into the air a great variety of fires.

92. *Fruloni Wheels.*

First have a nave made 9 inches long and 3 in diameter: near the bottom of this nave fix 8 spokes, with a hole in the end of each, large enough to receive a 2 or 4 ounce cafe: each of these spokes may be 14 inches long from the block. Near the top of this block fix 8 more of the same spokes, exactly over the others, but not so long by 2 inches. As this wheel is to run horizontally, all the cafes in the spokes must play obliquely upwards, and all those in the spokes at bottom obliquely downwards. This being done, have a small horizontal wheel made with 8 spokes, each 5 inches long from the block: on the top of this wheel place a cafe of brilliant fire: all the cafes on this wheel must play in an oblique direction downwards, and burn 2 at a time, and those on the large wheel 4 at a time; that is, 2 of those in the top set of spokes, and 2 of those in the bottom set of spokes.

The 4 first cafes on the large wheel, and the 2 first on the small, must be fired at the same time, and the brilliant fire at top at the beginning of the last cafes. The cafes of the wheels may be filled with a grey charge. When these wheels are completed, you must have a strong iron spindle, made 4 feet 6 inches long, and fixed perpendicularly on the top of a stand: on this put the large wheel, whose nave must have a hole quite through from the bottom to the top. This hole must be large enough to turn easy round the bottom of the spindle, at which place there must be a shoulder, to keep the wheel from touching the stand: at the top of the spindle put the small wheel, and join it to a large one with a leader, in order that they may be fired both together.

93. *Cascades of Fire,*

Are made of any size; but one made according to the dimensions of that shown in fig. 1. will be large enough for 8-oz. cafes. Let the distance from A to B be 3 feet; from B to C 2 feet 6 inches; and from CD 2 feet; and let the cross piece at A be 4 feet long: then from each end of this piece draw a line to D; then make the other cross pieces so long as to come within those lines. The top piece D may be of any length, so as to hold the cafes, at a little distance from each other; all the cross pieces are fixed horizontally, and supported by brackets; the bottom cross piece should be about 1 foot 6 inches broad in the middle, the second 1 foot, the third 9 inches, and the top piece 4 inches: the cafes may be made of any length, but must be filled with a brilliant charge. On the edges of the cross pieces must be nailed bits of wood, with a groove cut in each piece, large enough for a cafe to lie in. These bits of wood are fixed so as to incline downwards, and that the fire from one tier of cafes may play over the other. All the cafes being tied fast on, carry leaders from one to the other; and let there be a

pipe hung from the mouth of one of the cafes, covered at the end with a single paper, which you burn to fire the cascade.

94. *The Fire-Tree.*

To make a fire-tree, as shewn by fig. 2. you must first have a piece of wood 6 feet long, and 3 inches square; then at E, 9 inches from the top, make a hole in the front, and in each side; or, instead of holes, you may fix short pegs, to fit the inside of the cafes. At F, 9 inches from E, fix 3 more pegs; at G, 1 foot 9 inches from F, fix 3 pegs; at H, 9 inches from G, fix 3 pegs; at I, 9 inches from H, fix 3 pegs, inclining downwards; but all the other pegs must incline upwards, that the cafes may have the same inclination as you see in the figure: then at top place a 4-inch mortar, loaded with flars, rains, or crackers. In the middle of this mortar place a cafe filled with any sort of charge, but let it be fired with the other cafes: a brilliant charge will do for all the cafes; but the mortar may be made of any diameter, and the tree of any size; and on it any number of cafes, provided they are placed in the manner described.

95. *Chinese Fountains.*

To make a Chinese fountain, you must have a perpendicular piece of wood 7 feet long and 2½ inches square. Sixteen inches from the top, fix on the front a cross-piece 1 inch thick, and 2½ broad, with the broad side up: below this, fix 3 more pieces of the same width and thickness, at 16 inches from each other: let the bottom rail be 5 feet long, and the others of such a length as to allow the fire-pumps to stand in the middle of the intervals of each other. The pyramid being thus made, fix in the holes made in the bottom rail 5 fire-pumps, at equal distances; on the 2d rail, place 4 pumps; on the 3d, 3; on the 4th, 2; and on the top of the post, 1; but place them all to incline a little forwards, that, when they throw out the flars, they may not strike against the cross rails. Having fixed your fire-pumps, clothe them with leaders, so that they may all be fired together. See fig. 3.

96. *Of illuminated Globes with horizontal Wheels.*

The hoops for these globes may be made of wood, tin, or iron wire, about 2 feet diameter. For a single globe take two hoops, and tie them together, one within the other, at right angles; then have a horizontal wheel made, whose diameter must be a little wider than the globe, and its nave 6 inches long; on the top of which the globe is fixed, so as to stand 3 or 4 inches from the wheel: on this wheel you may put any number of cafes, filled with what charge you like; but let two of them burn at a time: they may be placed horizontally, or to incline downwards, just as you choose. Now, when the wheel is clothed, fix on the hoops as many illuminations as will stand within 2½ inches of each other: these you fasten on the hoops with small iron binding wire; and when they are all on, put on your pipes of communication, which must be so managed as to light them all with the 2d or 3d cafe on the wheel. The spindle on which the globe is to run must go through the block of the wheel, up to the inside of the top of the globe; where must be fixed a bit of brass, or iron, with a hole in it to receive the point of the spindle, on which the whole weight of the wheel is to bear, as in fig. 4. which represents a globe on its spindle. By this method may be made a

Of Wheels.
&c.

crown, which is done by having the hoops bent in the form of a crown. Sometimes globes and crowns are ordered so as to stand still, and the wheel only to turn round; but when you would have the globe or crown to stand still, and the wheel to run by itself, the block of the wheel must not be so long, nor the spindle any longer than to just raise the globe a little above the wheel; and the wheel cases and illumination must begin together.

97. *Dodecaedron,*

So called because it nearly represents a twelve-sided figure, is made thus. First have a ball turned out of some hard wood, 14 inches diameter: when done, divide its surface into 14 equal parts, from which bore holes $1\frac{1}{4}$ inch diameter, perpendicular to the centre, so that they may all meet in the middle: then let there be turned in the inside of each hole a female screw; and to all the holes but one, must be made a round spoke 5 feet long, with 4 inches of the screw at one end to fit the holes; then in the screw-end of all the spokes bore a hole, 5 inches up, which must be bored slanting, so as to come out at one side, a little above the screw; from which cut a small groove along the spoke, within 6 inches of the other end, where you make another hole through to the other side of the spoke. In this end fix a spindle, on which put a small wheel of 3 or 4 sides, each side 6 or 7 inches long: these sides must have grooves cut in them, large enough to receive a 2 or 4 oz. case. When these wheels are clothed, put them on the spindles, and at the end of each spindle put a nut to keep the wheel from falling off. The wheels being thus fixed, carry a pipe from the mouth of the first case on each wheel, through the hole in the side of the spoke, and from thence along the groove, and through the other hole, so as to hang out at the screw-end about an inch. The spokes being all prepared in this manner, you must have a post, on which you intend to fire the work, with an iron screw in the top of it, to fit one of the holes in the ball: on the screw fix the ball; then in the top hole of the ball put a little meal-powder, and some loose quick-match: then screw in all the spokes; and in one side of the ball bore a hole, in which put a leader, and secure it at the end; and your work will be ready to be fired. By this leader the powder and match in the centre is fired, which will light the match at the ends of the spokes all at once, whereby all the wheels will be lighted at once. There may be an addition to this piece, by fixing a small globe on each wheel, or one on the top wheel only. A grey charge will be proper for the wheel-cases.

98. *The Yew-Tree of brilliant Fire,*

Is represented by fig. 5. as it appears when burning. First, let A be an upright piece of wood, 4 feet long, 2 inches broad, and 1 thick: at top of this piece, on the flat side, fix a hoop 14 inches diameter; and round its edge and front place illuminations, and in the centre a 5-pointed star; then at E, which is $1\frac{1}{2}$ foot from the edge of the hoop, place 2 cases of brilliant fire, one on each side: these cases should be 1 foot long each; below these fix 2 more cases of the same size, and at such a distance, that their mouths may almost meet them at top; then close to the ends of these cases fix 2 more of the same cases; they must stand parallel to them at E. The cases being thus fixed, clothe them with leaders; so that they,

with the illuminations and stars at top, may all take fire together.

Of Wheels
&c.

99. *Stars with Points for regulated Pieces, &c.*

These stars are made of different sizes, according to the work for which they are intended: they are made with cases from 1 oz. to 1 lb. but in general with 4 oz. cases, 4 or 5 inches long: the cases must be rolled with paste, and twice as thick of paper as a rocket of the same bore. Having rolled a case, pinch one end of it quite close: then drive in $\frac{1}{4}$ a diameter of clay; and when the case is dry, fill it with composition, 2 or 3 inches to the length of the cases with which it is to burn: at top of the charge drive some clay; as the ends of these cases are seldom pinched, they would be liable to take fire. Having filled a case, divide the circumference of it at the pinched end close to the clay into 5 equal parts; then bore 5 holes with a gimblet, about the size of the neck of a common 4-oz. case, into the composition: from one hole to the other carry a quick match, and secure it with paper: this paper must be put on in the manner of that on the ends of wheel-cases, so that the hollow part, which projects from the end of the case, may serve to receive a leader from any other work, to give fire to the points of the stars. These stars may be made with any number of points.

100. *Fixed Sun with a transparent Face.*

To make a sun of the best sort, there should be two rows of cases, as in fig. 6. which will show a double glory, and make the rays strong and full. The frame, or sun-wheel, must be made thus: Have a circular flat nave made very strong, 12 inches diameter: to this fix 6 strong flat spokes, A, B, C, D, E, F. On the front of these fix a circular fell, 5 feet diameter; within which fix another fell, the length of one of the sun-cases less in diameter; within this fix a 3d fell, whose diameter must be less than the 2d by the length of 1 case and 1-3d. The wheel being made, divide the fells into so many equal parts as you would have cases (which may be done from 24 to 44): at each division fix a flat iron staple; these staples must be made to fit the cases, to hold them fast on the wheel; let the staples be so placed, that one row of cases may lie in the middle of the intervals of the other.

In the centre of the block of the sun drive a spindle, on which put a small hexagon wheel, whose cases must be filled with the same charge as the cases of the sun: two cases of this wheel must burn at a time, and begin with them on the fells. Having fixed on all the cases, carry pipes of communication from one to the other, as you see in the figure, and from one side of the sun to the wheel in the middle, and from thence to the other side of the sun. These leaders will hold the wheel steady while the sun is fixing up, and will also be a sure method of lighting both cases of the wheel together. A sun thus made is called a *brilliant sun*, because the wood work is entirely covered with fire from the wheel in the middle, so that there appears nothing but sparks of brilliant fire; but if you would have a transparent face in the centre, you must have one made of paste-board of any size. The method of making a face is, by cutting out the eyes, nose, and mouth, for the sparks of the wheel to appear through; but instead of this face, you may have one painted on oiled paper, or Persian silk, strained tight on a hoop; which

Of Wheels, which hoop must be supported by 3 or 4 pieces of wire at 6 inches distance from the wheel in the centre, so that the light of it may illuminate the face. By this method you may have, in the front of a sun, VIVAT REX, cut in pasteboard, or Apollo painted on silk; but, for a small collection, a sun with a single glory, and a wheel in front, will be most suitable. Half-pound cases, filled 10 inches with composition, will be a good size for a sun of 5 feet diameter; but, if larger, the cases must be greater in proportion.

101. *Three Vertical Wheels illuminated, which turn on their own Naves upon a horizontal Table.*

A plan of this is shown by fig. 7. Let D be a deal table 3 feet in diameter: this table must be fixed horizontally on the top of a post; on this post must be a perpendicular iron spindle, which must come through the centre of the table: then let A, B, C, be 3 spokes joined to a triangular flat piece of wood, in the middle of which make a hole to fit easily over the spindle: let E, F, G, be pieces of wood, 4 or 5 inches long each, and 2 inches square, fixed on the under sides of the spokes; in these pieces make holes lengthwise to receive the thin part of the blocks of the wheels, which, when in, are prevented from coming out by a small iron pin being run through the end of each. K, L, M, are 3 vertical octagon wheels, 18 inches diameter each: the blocks of these wheels must be long enough for 3 or 4 inches to rest on the table; round which part drive a number of sharp points of wire, which must not project out of the blocks more than 1-16th of an inch: the use of these points is, that, when the blocks run round, they will flick in the table, and help the wheels forward: if the naves are made of strong wood, one inch will be enough for the diameter of the thin part, which should be made to turn easy in the holes in the pieces E, F, G. On the front of the wheels make 4 or 5 circles of strong wire, or flat hoops, and tie on them as many illuminations as they will hold at 2 inches from each other: instead of circles, you may make spiral lines, clothed with illuminations, at the same distance from each other as those on the hoops. When illuminations are fixed on a spiral line in the front of a wheel, they must be placed a little on the flant, the contrary way that the wheel runs: the cases for these wheels may be filled with any coloured charge, but must burn only one at a time.

The wheels being thus prepared, you must have a globe, crown, or spiral wheel, to put on the spindle in the middle of the table: this spindle should be just long enough to raise the wheel of the globe, crown, or spiral wheel, so high that its fire may play over the 3 vertical wheels: by this means their fires will not be confused, nor will the wheels receive any damage from the fire of each other. In clothing this work, let the leaders be so managed, that all the wheels may light together, and the illuminations after 2 cases of each wheel are burned.

102. *Illuminated Chandelier.*

Illuminated works are much admired by the Italians, and indeed are a great addition to a collection of works: in a grand exhibition an illuminated piece should be fired after every two or three wheels, or fixed pieces of common and brilliant fires; and likewise illuminated works may be made cheap, quick, and easy.

To make an illuminated chandelier, you must first have one made of thin wood (see fig. 8.) The chandelier being made, bore in the front of the branches, and in the body, and also in the crown at top, as many holes for illuminations as they will contain at 3 inches distance from each other: in these holes put illuminations filled with white, blue, or brilliant charge. Having fixed in the port-fires, clothe them with leaders, so that the chandelier and crown may light together. The small circles on this figure represent the mouths of the illuminations, which must project straight from the front.

103. *Illuminated Tree.*

First have a tree made of wood, such as is shown by fig. 9. The middle piece or stem, on which the branches are fixed, must be 8 feet 6 inches high: at the bottom of this piece draw a line, at right angles, 2 feet 6 inches long at each side; then from L, which is 1 foot 6 inches from the bottom, draw a line on each side to C and D: these lines will give the length of the two first branches. Then put on the two top branches parallel to them at bottom: let the length of each of these branches be 1 foot from the stem: from the ends of these two branches draw a line to C and D: then fix on 5 more branches at an equal distance from each other, and their length will be determined by the lines AC and ED. When the branches are fixed, place illuminating portfires on the top of each, as many as you choose: behind the top of the stem fasten a gerbe or white fountain, which must be fired at the beginning of the illuminations on the tree.

104. *Flaming Stars with brilliant Wheels.*

To make a flaming star, you must first have made a circular piece of strong wood about 1 inch thick and 2 feet diameter: round this block fix 8 points, 2 feet 6 inches long each; 4 of these points must be straight and 4 flaming: these points being joined on very strong, and even with the surface of the block, nail tin or pasteboard on their edges, from the block to the end of each, where they must be joined: this tin must project in front 8 inches, and be joined where they meet at the block; round the front of the block fix 4 pieces of thick iron wire, 8 inches long each, equally distant from each other: this being done, cut a piece of pasteboard round, 2 feet diameter, and draw on it a star, as may be seen in fig. 10. Cut out this star, and on the back of it paste oiled paper; then paint each point half red and half yellow, lengthwise; but the body of the star must be left open, wherein must run a brilliant wheel, made thus: Have a light block turned 9 inches long: at each end of it fix 6 spokes; at the end of each spoke put a 2 ounce case of brilliant fire: the length of these cases must be in proportion to the wheel, and the diameter of the wheel when the cases are on must be a little less than the diameter of the body of the small star: the cases on the spokes in front must have their mouths incline outwards, and those on the inside spokes must be placed so as to form a vertical circle of fire. When you place your leaders, carry the first pipe from the tail of 1 of the cases in front to the mouth of 1 of the inside cases, and from the tail of that to another in front, and so on to all the cases. Your wheel being made, put it on a spindle, in the centre of the star; this spindle must have a shoulder at bottom, to keep the wheel at a little distance from the block. This wheel must be kept on the

Of Wheels,
&c.

the spindle by a nut at the end; having fixed on the wheel, fasten the transparent star to the 4 pieces of wire: when you fire it, you will only see a common horizontal wheel; but when the first case is burnt out, it will fire one of the vertical cases, which will show the transparent star, and fill the large flames and points with fire; then it will again appear like a common wheel, and so on for 12 changes.

105. *Projected regulated Piece of nine Mutations.*

A regulated piece, if well executed, is as curious as any in fire-works: it consists of fixed and moveable pieces on one spindle, representing various figures, which take fire successively one from another, without any assistance after lighting the first mutation. See fig. 11.

I. Names of the mutations, with the colour of fire and size of the case belonging to each.

First mutation is a hexagon vertical wheel, illuminated in front with small portfires tied on the spokes; this wheel must be clothed with 2 ounce cases, filled with black charge; the length of these cases is determined by the size of the wheel, but must burn singly.

Second mutation is a fixed piece, called a *golden glory*, by reason of the cases being filled with spur-fire. The cases must stand perpendicular to the block on which they are fixed, so that, when burning, they may represent a glory of fire. This mutation is generally composed of 5 or 7 two ounce cases.

Third mutation is moveable; and is only an octagon vertical wheel, clothed with 4 ounce cases, filled with brilliant charge: 2 of these cases must burn at a time. In this wheel you may make changes of fire.

Fourth mutation, is a fixed sun of brilliant fire, consisting of 12 four ounce cases: the necks of these cases must be a little larger than those of 4 ounce wheel-cases. In this mutation may be made a change of fire, by filling the cases half with brilliant charge, and half with grey.

Fifth mutation, is a fixed piece, called the *porcupine's quills*. This piece consists of 12 spokes, standing perpendicular to the block in which they are fixed; on each of these spokes, near the end, must be placed a 4 ounce case of brilliant fire. All these cases must incline either to the right or left, so that they may all play one way.

Sixth mutation, is a standing piece, called the *cross fire*. This mutation consists of 8 spokes fixed in a block; near the end of each of those spokes must be tied two 4 ounce cases of white charge, one across the other, so that the fires from the cases on one spoke may intersect the fire from the cases on the other.

Seventh mutation, is a fixed wheel, with 2 circular fells, on which are placed 16 eight-ounce cases of brilliant fire, in the form of a star. This piece is called a *fixed star of wild-fire*.

Eighth mutation. This is a beautiful piece, called a *brilliant star-piece*. It consists of 6 spokes, which are strengthened by 2 fells of a hexagon form, at some distance from each other: at the end of each spoke, in the front, is fixed a brilliant star of 5 points; and on each side of every star is placed a 4 ounce case of black or grey charge; these cases must be placed with their mouths sidewise, so that their fires may cross each other.

Ninth mutation, is a wheel-piece. This is composed of 6 long spokes, with a hexagon vertical wheel at the end of each; these wheels run on spindles in the front of the spokes; all the wheels are lighted together: 2 ounce cases will do for these wheels, and may be filled with any coloured charge.

II. Proportions of the mutations, with the method of conveying the fire from one to the other, and the distance they stand one from the other on the spindle.

First Mutation, must be a hexagon vertical wheel, 14 inches diameter; on one side of the block, whose diameter is $2\frac{1}{4}$ inches, is fixed a tin barrel A (see fig. 11. n^o 1.) This barrel must be a little less in diameter than the nave; let the length of the barrel and block be 6 inches. Having fixed the cases on the wheel, carry a leader from the tail of the last case into the tin barrel through a hole made on purpose, 2 inches from the block; at the end of this leader let there be about 1 inch or 2 of loose match; but take care to secure well the hole wherein the pipe is put, to prevent any sparks falling in, which would light the second mutation before its time, and confuse the whole.

Second mutation is thus made. Have a nave turned $2\frac{1}{2}$ inches diameter, and 3 long; then let $\frac{1}{2}$ an inch of that end which faces the first wheel be turned so as to fit easy into the tin barrel of the first mutation, which must turn round it without touching. On the other end of the block fix a tin barrel B, n^o 2. This barrel must be 6 inches long, and only half an inch of it to fit on the block. Round the nave fix 5 spokes, $1\frac{1}{2}$ inch long each; the diameter of the spokes must be equal to a 2 oz. former. On these spokes put five 7-inch 2-oz. cases of spur-fire, and carry leaders from the mouth of one to the other, that they may all light together. Then from the mouth of one of the cases carry a leader through a hole bored slantwise in the nave, from between the spokes, to the front of the block near the spindle hole: the end of this leader must project out of the hole into the barrel of the first mutation, so that when the pipe which comes from the end of the last case on the first wheel flashes, it may take fire, and light the 2d mutation. To communicate the fire to the 3d mutation, bore a hole near the bottom of one of the 5 cases to the composition, and from thence carry a leader into a hole made in the middle of the barrel B: this hole must be covered with pasted paper.

Third mutation, may be either an octagon or hexagon wheel, 20 inches diameter; let the nave be $3\frac{1}{4}$ inches diameter, and $3\frac{1}{2}$ in length; $1\frac{1}{2}$ inch of the front of the nave must be made to fit in the barrel B. On the other end of the block fix a tin barrel C, n^o 3. This barrel must be $6\frac{1}{2}$ inches in length, one inch of which must fit over the block. The cases of this wheel must burn 2 at a time; and from the mouths of the 2 first cases carry a leader, through holes in the nave, into the barrel of the second mutation, after the usual manner: but besides these leaders let a pipe go across the wheel from one first case to the other; then from the tail of one of the last cases carry a pipe into a hole in the middle of the barrel C: at the end of this pipe let there be some loose quick-match.

Fourth and Fifth mutations. These may be described under

Of Wheels,
&c.

Of Wheels, under one head, as their naves are made of one piece, which from E to F is 14 inches; E, a block 4 inches diameter, with 10 or 12 short spokes, on which are fixed 11-inch 8-oz. cafes; let the front of this block be made to fit easy in the barrel C, and clothe the cafes so that they may all light together; and let a pipe be carried through a hole in the block into the barrel C, in order to receive the fire from the leader brought from the last cafe on the wheel. G is the nave of the 5th mutation, whose diameter must be 4½ inches: in this nave fix 10 or 12 spokes, 1½ foot in length each; these spokes must stand 7 inches distant from the spokes of the 4th mutation; and at the end of each spoke tie a 4-oz. cafe, as n° 5. All these cafes are to be lighted together, by a leader brought from the end of one of the cafes on n° 4. Let F and H be of the same piece of wood as E and G, but as much thinner as possible, to make the work light.

Sixth and seventh mutations. The blocks of these 2 mutations are turned out of one piece of wood, whose length from F to P is 15 inches. L, a block 5 inches diameter, in which are fixed 8 spokes, each 2 feet 4 inches long; at the end of each spoke tie two 4-oz. cafes, as n° 6. All these cafes must be fired at the same time, by a pipe brought from the end of one of the cafes on the 5th mutation. Let the distance between the spokes at L, and those in the 5th mutation, be 7 inches. M, the nave of the 7th mutation, whose diameter must be 5½ inches: in this nave fix 8 spokes, and on the front of them 2 circular fells, one of 4 feet 8 inches diameter, and one of 3 feet 11 inches diameter; on these fells tie 16 8-oz. or pound cafes, as in n° 7. and carry leaders from one to the other, so that they may be all fired together. This mutation must be fired by a leader brought from the tail of one of the cafes on the 6th mutation.

Eighth and ninth mutations. The blocks of these may be turned out of one piece, whose length from P to D must be 12 inches. O, the block of the 8th mutation, which must be 6 inches diameter; and in it must be fixed 6 spokes, each 3 feet in length, strengthened by an hexagon fell within 3 or 4 inches of the ends of the spokes: close to the end of each spoke, in the front, fix a five-pointed brilliant star; then 7 inches below each star tie two 10-inch 8 oz. cafes, so that the upper ends of the cafes may rest on the fells, and their ends on the spokes. Each of these cafes must be placed parallel to the opposite fell (see n° 8.) NNN, &c. are the cafes, and kkk, &c. the stars.

The 9th mutation is thus made. Let D be a block 7 inches diameter. In this block must be screwed 6 spokes, 6 feet long each, with holes and grooves for leaders, as those in the dodecaedron; at the end of each spoke, in the front, fix a spindle for a hexagon vertical wheel, 10 inches diameter, as in n° 9. When these wheels are on, carry a leader from each into the block, so that they may all meet; then lead a pipe from the end of one of the cafes of the 8th mutation, through a hole bored in the block D, to meet the leaders from the vertical wheels, so that they may all be fired together.

The spindles for larger pieces are required to be made very strong, and as exact as possible: for a piece of 9 mutations, let the spindle be at the large end 1 inch diameter, and continue that thickness as far as the

7th mutation; and thence to the 5th, let its diameter be ¾ of an inch; from the 5th to the 4th, 5-8ths of an inch; from the 4th to the 2d, ½ inch; and from the 2d to the end, 3-8ths of an inch. At the small end must be a nut to keep on the first wheel, and at the thick end must be a large nut, as shown by the figure; so that the screw part of the spindle being put through a post, and a nut screwed on tight, the spindle will be held fast and steady: but you are to observe, that that part of the spindle on which the moveable pieces are to run, be made long enough for the wheels to run easy without sticking; the fixed pieces being made on different blocks, the leaders must be joined, after they are fixed on the spindle. The best method of preventing the fixed mutations from moving on the spindle, is to make that part of the spindle which goes through them square; but as it would be difficult to make square holes through such long blocks as are sometimes required, it will be best to make them thus: Bore a hole a little larger than the diameter of the spindle; and at each end of the block, over the hole, fasten a piece of brass with a square hole in it to fit the spindle.

106. *To make an Horizontal Wheel change to a Vertical Wheel with a Sun in front.*

The sudden change of this piece is very pleasing; and gives great surprise to those who are not acquainted with the contrivance. A wheel for this purpose should be about three feet diameter, and its fell circular; on which tie 16 half-pound cafes filled with brilliant charge: two of these cafes must burn at a time; and on each end of the nave must be a tin barrel of the same construction as those on the regulated piece. The wheel being completed, prepare the post or stand thus: First have a stand made of any height, about three or four inches square; then saw off from the top a piece two feet long; this piece join again at the place where it was cut, with a hinge on one side, so that it may lift up and down in the front of the stand; then fix on the top of the bottom-part of the stand, on each side, a bracket; which brackets must project at right angles with the stand, one foot from the front, for the short piece to rest on. These brackets must be placed a little above the joint of the post, so that when the upper stand falls, it may lie between them at right angles with the bottom stand; which may be done by fixing a piece of wood, one foot long, between the brackets, and even with the top of the bottom stand; then, as the brackets rise above the bottom stand, they will form a channel for the short post to lie in, and keep it steady without straining the hinge. On the side of the short post, opposite the hinge, nail a piece of wood, of such a length, that, when the post is perpendicular, it may reach about 1½ feet down the long post; to which being tied, it will hold the short stand upright. The stand being thus prepared, in the top of it fix a spindle 10 inches long: on this spindle put the wheel: then fix on a brilliant sun with a single glory; the diameter of this sun must be 6 inches less than that of the wheel. When you fire this piece, light the wheel first, and let it run horizontally till four cafes are consumed: then from the end of the fourth cafe carry a leader into the tin barrel that turns over the end of the stand: this leader must be met by another brought through the top of the post, from a cafe filled with a strong port.

Of Wheels,
&c.

port-fire charge, and tied to the bottom post, with its mouth facing the packthread which holds up the stand; so that when this case is lighted, it will burn the packthread, and let the wheel fall forward, by which means it will become vertical: then from the last case of the wheel, carry a leader into the barrel next the sun, which will begin as soon as the wheel is burnt out.

107. *Grand Volute illuminated with a projected Wheel in front.*

Plate
ccccxxi.

First have two hoops made of strong iron wire, one of 6 feet diameter, and one of 4 feet 2 inches; these hoops must be joined to scrolls A, A, A, &c. as in fig. 1. These scrolls must be made of the same sort of wire as the hoops; on these scrolls tie, with iron-binding wire, as many illuminating port-fires as they will hold, at two inches distance; clothe these port-fires with leaders, so that they may all take fire together.—Then let C be a circular wheel of four spokes, 3 feet 6 inches diameter; and on its fell tie as many 4-oz. cases, head to tail, as will complete the circle, only allowing a sufficient distance between the cases, that the fire may pass free; which may be done by cutting the upper part of the end of each case a little shelving: on each spoke fix a 4-oz. case, about three inches from the fell of the wheel: these cases are to burn one at a time, and the first of them to begin with those on the fell, of which four are to burn at a time; so that the wheel will last no longer than $\frac{1}{4}$ of the cases on the fell, which in number should be 16 or 20. On the front of the wheel form a spiral line with strong wire, on which tie port-fires, placing them on a slant, with their mouths to face the same way as the cases on the wheel: all these port-fires must be fired with the second cases of wheel. Let D, D, D, &c. be spokes of wood, all made to screw into a block in the centre; each of these spokes may be in length about 4 feet 6 inches; in the top of each fix a spindle, and on each spindle put a spiral wheel of 8 spokes, such as E, E, E, &c. The blocks of these wheels must have a hole at top for the centre cases, and the spindle must have nuts screwed on their ends; which nuts should fit in the holes at top of the blocks, so that all the wheels must be put on before you fix in the centre cases: as some of these wheels, by reason of their situation, will not bear on the nut, it will be necessary to have smooth shoulders made on the spindles for the blocks to run on. The cases of these wheels are to burn double; and the method of firing them, is by carrying a leader from each down the spokes into the block in the centre, as in the dodecaedron, but the centre case of each wheel must begin with the two last cases as usual. It is to be observed, that the large circular wheel in front must have a tin barrel on its block, into which a pipe must be carried from one of the second cases on the wheel; this pipe being met by another from the large block, in which the 8 spokes are screwed, will fire all the spiral wheels and the illuminating port-fires at the same time. The cases of the projected wheel may be filled with a white charge, and those of the spiral wheels with a grey.

108. *Moon and Seven Stars.*

Let fig. 2. be a smooth circular board 6 feet diameter: out of the middle of it cut a circular piece 12 or 14 inches diameter; and over the vacancy put white Persian silk, on which paint a moon's face: then let

I, I, I, &c. be stars, each 4 or 5 inches diameter, cut out with five points, and covered with oiled silk: on the front of the large circular board draw a 7-pointed star, as large as the circle will allow; then on the lines which form this star, bore holes, wherein fix pointed stars. When this case is to be fired, it must be fixed upon the front of a post, on a spindle, with a wheel of brilliant fire behind the face of the moon: so that, while the wheel burns, the moon and stars will appear transparent: and when the wheel has burnt out, they will disappear, and the large star in front, which is formed of pointed stars, will begin, being lighted by a pipe of communication from the last case of the vertical wheel, behind the moon; this pipe must be managed in the same manner as those in regulated pieces.

109. *Double Cone-Wheel illuminated.*

This piece is represented by fig. 3. Let A be a strong decagon wheel, 2 feet 6 inches diameter; then on each side of it fix a cone B and C: these cones are to consist of a number of hoops, supported by 3 or 4 pieces of wood, in the manner of the spiral wheels. Let the height of each cone be 3 feet 6 inches; and on all the hoops tie port-fires horizontally, with their mouths outwards, and clothe the wheel with 8-oz. cases, all to play horizontally, two at a time: the cones may be fired with the first or second cases. The spindle for this piece must go through both the cones, and rise three feet above the point of the cone at top; so that its length will be 10 feet 4 inches from the top of the post H, in which it is fixed, allowing four inches for the thickness of the block of the wheel. The whole weight of the wheel and cones must bear on a shoulder in the spindle, on which the block of the wheel must turn.—Near the top of the spindle must be a hole in the front, into which screw a small spindle, after the cones are on: then on this small spindle fix a sun D, composed of sixteen 9-inch 4-oz. cases of brilliant fire; which cases must not be placed on a fell, but only stuck into a block of 6 inches diameter: then in the front of this sun must be a circular vertical wheel, 16 inches diameter; on the front of this wheel form with iron-wire a spiral line, and clothe it with illuminations after the usual method. As this wheel is not to be fired till the cones are burnt out, the method of firing it is thus: Let the hole in the block, at the top of the uppermost cone, be a little larger than the spindle which passes through it. Then, from the first case of the vertical wheel before the sun, carry a leader down the side of the spindle to the top of the block of the horizontal wheel, on which must be a tin barrel: then this leader being met by another brought from the end of the last case of the horizontal wheel, will give fire to the vertical wheel so soon as the cones are extinguished: but the sun D must not be fired till the vertical wheel is quite burnt out.

110. *Fire-pumps.*

Cases for fire-pumps are made as those for tourbillons; only they are paited, instead of being rolled dry. Having rolled and dried your cases, fill them: first put in a little meal-powder, and then a star; on which ram lightly a ladle or two of composition, then a little meal-powder, and on that a star, then again composition; and so on till you have filled the case. Stars for fire-pumps should not be round; but must be made either square, or flat and circular, with a hole through the middle:

Wheels, &c. middle : the quantity of powder for throwing the stars must increase as you come near the top of the case ; for, if much powder be put at the bottom, it will burst the case. The stars must differ in size in this manner : Let the star which you put in first be about $\frac{1}{4}$ less than the bore of the case ; but let the next star be a little larger, and the third star a little larger than the second, and so on : let them increase in diameter till within two of the top of the case, which two must fit in tight. As the loading of fire-pumps is somewhat difficult, it will be necessary to make two or three trials before you depend on their performance : when you fill a number of pumps, take care not to put in each an equal quantity of charge between the stars, so that when they are fired, they may not throw up too many stars together. Cases for fire-pumps should be made very strong, and rolled on 4 or 8 oz. formers, 10 or 12 inches long each.

111. Vertical Scroll Wheel.

Plate
CCCCXXXI.

This wheel may be made of any diameter, but must be constructed as in fig. 4. to do which proceed thus : Have a block made of a moderate size, in which fix four flat spokes, and on them fix a flat circular fell of wood ; round the front of this fell place port-fires ; then on the front of the spokes form a scroll, either with a hoop or strong iron wire ; on this scroll tie cases of brilliant fire, in proportion to the wheel, head to tail, as in the figure. When you fire this wheel, light the first case near the fell ; then, as the cases fire successively, you will see the circle of fire gradually diminish : but whether the illuminations on the fell begin with the scroll or not, is immaterial, that being left entirely to the maker.

N. B. This wheel may be put in the front of a regulated piece, or fired by itself, occasionally.

112. Pin-Wheels.

First roll some paper pipes, about 14 inches long each ; these pipes must not be made thick of paper, two or three rounds of elephant paper being sufficient. When your pipes are thoroughly dried, you must have a tin tube 12 inches long, to fit easy into the pipes ; at one end of this tube fix a small conical cup, which cone is called a *funnel* ; then bend one end of one of the pipes, and put the funnel in at the other as far as it will reach, and fill the cup with composition : then draw out the funnel by a little at a time, shaking it up and down, and it will fill the pipe as it comes out. Having filled some pipes, have some small blocks made about one inch diameter and half an inch thick : round one of these blocks wind and paste a pipe, and to the end of this pipe join another ; which must be done by twisting the end of one pipe to a point, and putting it into the end of the other with a little paste : in this manner join four or five pipes, winding them one upon the other so as to form a spiral line. Having wound on your pipes, paste two slips of paper across them to hold them together : besides these slips of paper, the pipes must be pasted together.

There is another method of making these wheels, viz. by winding on the pipes without paste, and sticking them together with sealing-wax at every half turn ; so that when they are fired, the end will fall loose every time the fire passes the wax, by which means the circle of fire will be considerably increased. The formers for these pipes are made from $1\frac{1}{2}$ to 4-16ths of an inch

diameter ; and the composition for them is as follows : Different Pieces of Fire-works.
Meal-powder 8 oz. saltpetre 2 oz. and sulphur 1 : among these ingredients may be mixed a little steel-filings or the dust of cast iron : this composition should be very dry, and not made too fine, or it will stick in the funnel. These wheels may be fired on a large pin, and held in the hand with safety.

113. Fire-globes.

There are two sorts of fire-globes ; one with projected cases ; the other with the cases concealed, thus : Have a globe made of wood, of any diameter you choose, and divide the surface of it into 14 equal parts, and at each division bore a hole perpendicular to the centre : these holes must be in proportion to the cases intended to be used : in every hole except one, put a case filled with brilliant, or any other charge, and let the mouths of the cases be even with the surface of the globe ; then cut in the globe a groove, from the mouth of one case to the other, for leaders, which must be carried from case to case, so that they may all be fired together ; this done, cover the globe with a single paper, and paint it. These globes may be used to ornament a building.

Fire-globes with projected cases are made thus : Your globe being made with 14 holes bored in it as usual, fix in every hole except one, a case, and let each case project from the globe two-thirds of its length ; then clothe all the cases with leaders, so that they may all take fire at the same time. Fire-globes are supported by a pintle, made to fit the hole in which there is no case.

114. To thread and join Leaders, and place them on different Works.

Joining and placing leaders is a very essential part of fire-works, as it is on the leaders that the performance of all complex works depends ; for which reason the method of conducting pipes of communication shall be here explained in as plain a manner as possible. Your works being ready to be clothed, proceed thus : Cut your pipes of a sufficient length to reach from one case to the other ; then put in the quick-match, which must always be made to go in very easy : when the match is in, cut it off within about an inch of the end of the pipe, and let it project as much at the other end ; then fasten the pipe to the mouth of each case with a pin, and put the loose ends of the match into the mouths of the cases, with a little meal-powder : this done to all the cases, paste over the mouth of each two or three bits of paper. The preceding method is used for large cases, and the following for small, and for illuminations : First thread a long pipe ; then lay it on the tops of the cases, and cut a bit of the under side, over the mouth of each case, so that the match may appear : then pin the pipe to every other case ; but before you put on the pipes, put a little meal-powder in the mouth of each case. If the cases thus clothed are port-fires on illuminated works, cover the mouth of each case with a single paper ; but if they are choaked cases, situated so that a number of sparks from other works may fall on them before they are fired, secure them with three or four papers, which must be pasted on very smooth, that there may be no creases for the sparks to lodge in, which often set fire to the works before their time. Avoid as much as possible placing the leaders too near, or one across the other so as to touch, as it may happen that the flash of one

will fire the other ; therefore if your works should be so formed that the leaders must cross or touch, be sure to make them very strong, and secure at the joints, and at every opening.

When a great length of pipe is required, it must be made by joining several pipes in this manner : Having put on one length of match as many pipes as it will hold, paste paper over every joint ; but, if a still greater length is required, more pipes must be joined, by cutting about an inch off one side of each pipe near the end, and laying the quick-match together, and tying them fast with small twine ; after which, cover the joining with pasted paper.

115. *Placing Fire-works to be exhibited.*

Nothing adds more to the appearance of fire-works than the placing them properly ; though the manner of placing them chiefly depends on the judgment of the maker. The following are the rules generally observed, whether the works are to be fired on a building or on stands : If they are a double set, place one wheel of a sort on each side of the building ; and next to each of them, towards the centre, place a fixed piece, then wheels, and so on ; leaving a sufficient distance between them for the fire to play from one without burning the other. Having fixed some of your works thus in front, place the rest behind them, in the centre of their intervals : The largest piece, which is generally a regulated or transparent piece, must be placed in the centre of the building, and behind it a sun, which must always stand above all the other works : A little before the building, or stands, place your large gerbes ; and at the back of the works fix your marron batteries, *pots des aigrettes*, *pots des brins*, *pots des saucissons*, air-balloons, and flights of rockets : The rocket stands may be fixed behind, or anywhere else, so as not to be in the way of the works.

Single collections are fired on stands ; which stands are made in the same manner as theodolite stands, only the top part must be long or short occasionally : these stands may be fixed up very soon without much trouble.

116. *Order of Firing.*

1. Two signal
2. Six sky
3. Two honorary
4. Four caduceus
5. } vertical
6. } Two { spiral } wheels illuminated
7. } transparent stars
8. A line rocket of five changes
9. Four tourbillons
10. } horizontal wheels
11. } air balloons illuminated
12. } Two { Chinese fountains
13. } regulating pieces of four mutations each
14. } pots des aigrettes
15. Three large gerbes
16. A flight of rockets
17. } Two { balloon wheels
18. } cascades of brilliant fire
19. Twelve sky-rockets
20. } Two { illuminated yew trees
21. } air-balloons of serpents, and 2 compound
22. Four tourbillons

23. } Two { Fruiloni wheels
24. } illuminated globes with horizontal wheels
25. One pot des saucissons
26. Two plural wheels
27. Marron battery
28. Two chandeliers illuminated
29. Range of pots des brins
30. Twelve sky-rockets
31. Two yew-trees of fire
32. Nest of serpents
33. Two double cones illuminated
34. Regulating piece of seven mutations, viz.
 1. Vertical wheel illuminated
 2. Golden glory
 3. Octagon vertical wheel
 4. Porcupine's quills
 5. Cross fires
 6. Star-piece with brilliant rays
 7. Six vertical wheels
35. Brilliant sun
36. Large flight of rockets.

When water-works are to be exhibited, divide them into several sets, and fire one set after every fifth or sixth change of land and air-works. Observe this rule in firing a double set of works : Always begin with sky-rockets, then two moveable pieces, then two fixed pieces, and so on ; ending with a large flight of rockets, or a marron battery : if a single collection, fire a fixed piece after every wheel or two, and now and then some air and water-works.

117. *Fountain of Sky-rockets.*

Fig. 5. represents a fountain of 30 rockets. Let A be a perpendicular post, 16 feet high from the ground, and 4 inches square. Let the rail, or cross piece C, be 1 foot 6 inches long, 3 inches broad, and 1 thick. The rail D, at bottom, must be 6 feet long, 1 foot broad, and 1 inch thick. F and G are the two sides which serve to supply the rails D, E, H, I, C : these sides are 1 foot broad at bottom, and cut in the front with a regular slope, to 3 inches at top ; but their back edges must be parallel with the front of the pots A. The breadth of the rails E, H, I, will be determined by the breadth of the sides : all the rails must be fixed at 2 feet distance from each other, and at right angles with the pots. Having placed the rails thus, bore in the bottom rail 10 holes, at equal distances, large enough to receive the stick of a one-pound rocket : in the back edge of this rail cut a groove from one end to the other, fit to contain a quick-match ; then cut a groove in the top of the rail, from the edge of each hole, into the groove in the back : in the same manner cut in the second rail, E, 8 holes and grooves ; in the third rail, H, 6 holes and grooves ; in the fourth rail, I, 4 holes and grooves ; and in the top rail, 2 holes and grooves. B, a rail with holes in it to guide the ends of the rocket-sticks : this rail must be fixed 6 feet from the rail D. The fountain frame being thus made, prepare your rockets thus : Tie round the mouth of each a piece of thin paper, large enough to go twice round, and to project about $1\frac{1}{2}$ inch from the mouth of the rocket, which must be rubbed with wet meal-powder ; in the mouth of each rocket put a leader, which secure well with the paper that projects from the mouth of the case : these leaders must be carried into the grooves in

Different
Pieces of
Fire-works.

in the back of the rails, in which lay a quick-match from one end to the other, and cover it with pasted paper: holes must be made in the rail D, to receive the ends of the sticks of the rockets in the rail E, and so on to the fourth rail; so that the sticks of the rockets at top will go through all the rails. The rockets being so prepared, fix a gerbe, or white flower-pot, on each rail, before the post, with their mouths inclining a little forwards: these gerbes must be lighted all at once. Behind or before each gerbe, fix a case of brilliant or slow fire: these cases must be filled so that they may burn out one after the other, to regulate the fountain; which may be done by carrying a leader from the end of each slow or brilliant fire, into the groove in the back of each rail. Different fixed rockets may be used in these fountains: but it will be best to fill the heads of the rockets on each rail with different sorts of things, in this manner; those at top with crackers, the next with rains, the third with serpents, the fourth with tailed stars, and the last slight with common or brilliant stars.

118. Palm Tree.

This piece, though made of common fires, and of a simple construction, has a very pleasing effect; owing to the fires intersecting so often, that they resemble the branches of trees. Let A (fig. 6.) be a perpendicular post, of any thickness, so that it is sufficiently strong to hold the cases; let the distance from B to C be 2 feet 6 inches, and C to D 2 feet 6 inches, and let the length of each cross piece be 2 feet; on each end of each fix a five-pointed star: then fix, on pegs made on purpose, 12-inch half-pound cases of brilliant fire, as in the figure. All the cases and stars must be fired at once. This piece should be fixed high from the ground.

119. Illuminated Pyramid, with Archimedian Screws, a Globe, and vertical Sun,

May be of any size. One made according to the dimensions of fig. 7. will be a good proportion, whose height is 21 feet; from C to D, 6 feet; from E to F, 9 feet: the space between the rails must be 6 inches, and the rails as thin as possible: in all the rails stick port-fires at four inches distance. The Archimedian screws, G, K, are nothing more than double spiral wheels, with the cases placed on their wheels horizontally instead of obliquely. The vertical sun, I, need not consist of more than 12 rays, to form a single glory. The globe at top must be made in proportion to the pyramid; which being prepared according to the preceding directions, place your leaders so that all the illuminating port-fires, screws, globe, and sun, may take fire together. The pyramid must be supported by the two sides, and by a support brought from a pole, which must be placed two feet from the back of the pyramid, that the wheels may run free.

120. Rose-piece and Sun.

A rose-piece may be used for a mutation of a regulated piece, or fired by itself: it makes the best appearance when made large; if its exterior diameter be 6 feet, it will be a good size. Fig. 8. shows the manner it appears in before it is fired. Let the exterior fell be made of wood, and supported by 4 wooden spokes: all the other parts, on which the illuminations are fixed, must be made of strong iron wire: on the exterior fell place as many half-pound cases of brilliant charge as you think proper, but the more the better;

for the nearer the cases are placed, the stronger will be the rays of the sun: the illuminations should be placed within 3 inches of each other: they must all be fired together, and burn some time before the sun is lighted; which may be done by carrying a leader from the middle of one of the illuminations, to the mouth of one of the sun cases.

121. Transparent Stars with illuminated Rays.

Fig. 9. represents an illuminated star. Let the diameter from A to B be 2 feet, and from C to D 7 feet. First make a strong circular back or body of the star, 2 feet diameter, to which you fix the illuminated rays: in the centre of the front of the body fix a spindle, on which put a double triangular wheel, 6 inches diameter, clothed with 2 ounce cases of brilliant charge: the cases on this wheel must burn but one at a time. Round the edge of the body nail a hoop made of thin wood or tin: this hoop must project in front 6 or 7 inches: in this hoop cut 3 or 4 holes to let out the smoke from the wheel. The star and garter may be cut out of strong pasteboard or tin, made in this manner: Cut a round piece of pasteboard or tin, 2 feet diameter, on which draw a star, and cut it out; then over the vacancy paste Persian silk; paint the letters yellow; 4 of the rays yellow, and 4 red; the crosses in the middle may be painted half red and half yellow, or yellow and blue. This transparent star must be fastened to the wooden hoop by a screw, to take off and on; the illuminated rays are made of thin wood, with tin sockets fixed on their sides within 4 inches of each other; in these sockets stick illuminating port-fires; behind the point of each ray fix a half-pound case of grey, black, or Chinese fire.

N. B. The illuminated rays to be lighted at the same time as the triangular wheel, or after it is burnt out; which may be done by a tin barrel being fixed to the wheel, after the manner of those in the regulated pieces. Into this barrel carry a leader from the illuminated rays, through the back of the star; which leader must be met by another, brought from the tail of the last case on the wheel.

122. Transparent Table Star illuminated.

Fig. 1. represents a table star, whose diameter, from E to F, is 12 feet; and from E to I, 4 feet. This proportion, observed on each side, will make the centre frame 4 feet square: in this square fix a transparent star, as in the figure. This star may be painted blue, and its rays made as those of the flaming stars described before. The wheel for this star may be composed of different coloured fires, with a charge or two of slow fire; the wheels a, a, a, a, may be clothed with any number of cases, so that the star-wheel consist of the same: the illuminating port-fires, which must be placed very near each other on the frames, must be so managed as to burn as long as the wheels, and lighted at the same time.

123. The regulated illuminated Spiral Piece, with a projected Star-wheel illuminated.

This piece is represented by fig. 2. and is thus made. Have a block made 8 inches diameter; in this block screw 6 iron spokes, which must serve for spindles for the spiral wheels: these wheels are made as usual, each 1½ foot diameter, and 3 feet in height: the spindles must be long enough to keep the wheels 4 or 5 inches from one another: at the end of each spindle must be a

4 X 2

screw-

Different
Pieces of
Fire-works.

Plate
CCCCXXXI.

Plate
CCCCXXXI.

Plate
CCCCXXXII.

Different
Pieces of
Fire-works

screw-nut, on which the wheels that hang downwards will run; and on the spindles which stand upwards must be a shoulder, for the blocks of the wheels to run on.

The projected star-wheel must turn on the same spindle on which the large block is fixed; this spindle must be long enough to allow the star-wheel to project a little before the spiral wheels: the exterior diameter of the star-wheel must be 3 feet 5. On this wheel fix 3 circles of iron wire, and on them port-fires; on the block place a transparent star, or a large 5-pointed brilliant star. The cafes on this wheel may burn 4 at once, as it will contain near twice the number of one of the spiral wheels: the cafes on the spiral wheels must be placed parallel to their fells, and burn two at a time.

125. *A Figure-piece illuminated with five-pointed Stars.*

Plate
CCCCXXII.

The construction of this piece is very easy, as shown by fig. 3. whose diameter from B to C is 8 feet, and from D to F 2 feet: the vertical wheel in the centre must be 1 foot diameter, and consist of 6 four-ounce cafes of different coloured charge, which cafes must burn double: on the frames fix 5 pointed brilliant or blue stars, rammed 4 inches with composition: let the space between each star be 8 inches; at each point fix a gerbe, or case of Chinese fire. When to be fired, let the gerbe, stars, and wheel, be lighted at the same time.

125. *The Star-wheel illuminated.*

This beautiful piece is shown by fig. 4. Its exterior fell is made of wood, 3 feet 6, or 4 feet diameter; within this fell, form with iron wire 3 circles, one less than the other, so that the diameter of the least may be about 10 inches: place the port-fires on these fells with their mouths inclining outwards, and the port-fires on the points of the star with their mouths projecting in front: let the exterior fell be clothed with 4 ounce cafes of grey charge: these cafes must burn 4 at a time, and be lighted at the same time as the illuminations.

126. *Pyramid of Flower-pots.*

Fig. 5. represents this curious piece, which must be made thus. Let the distance from A to B be 6 feet; and from one rail to the other, 2: on the bottom rail fix 5 paper mortars, each $3\frac{1}{2}$ inches diameter; these mortars load with serpents, crackers, stars, &c.

In the centre of each mortar fix a case of spur-fire: on the second rail fix 4 mortars, so as to stand exactly in the middle of the intervals of them on the bottom rail; on the third rail place 3 mortars; on the fourth, 2; and on the top of the posts, 1: the bottom rail must be 6 feet long: all the mortars must incline a little forwards, that they may easily discharge; and the spur-fires rammed exactly alike, that the mortars may all be fired at the same time. Having prepared your pyramid according to the preceding directions, carry pipes of communication from one spur-fire to the other.

127. *The illuminated Regulating Piece.*

Fig. 6. represents one half of this piece. A, A, A, A, are flat wooden spokes, each 5 feet long: at the end of each place a vertical wheel, 10 inches diameter, clothed with 6 four-ounce cafes of brilliant fire: these cafes must burn but 1 at a time: on two of the spokes of each wheel place 2 port-fires, which must be lighted with the first case of the wheel; on each spoke A, A, &c. behind the wheels, place 6 cafes of the same size with those on the wheels: these cafes must be tied across the spokes with their mouths all one way,

and be made to take fire successively one after the other, so that they may assist the whole pieces to turn round.

Different
Pieces of
Fire-works.

The diameter of the large wheel must be $2\frac{1}{2}$ feet; and its fell made of wood, which must be fixed to the large spokes: on this wheel place 24 cafes of the same sort: with those on the small wheels; these cafes must burn 4 at a time: in this wheel make 3 circles with iron wire, and on them place illuminating port-fires, as in the figure: the star-points on the large spokes may be made of thin ash-hoops; the diameter of these points close to the centre-wheel must be 11 inches: on these points place port-fires, at $3\frac{1}{2}$ inches distance one from the other.

Fig. 7. represents the blocks of this piece. The diameters of these blocks, at A and B, must be 3 inches; and C and D, $4\frac{1}{2}$ inches: the length of each of these blocks must be 6 inches: at the small ends of these blocks fix an iron wheel 5 inches diameter, which wheels must have teeth, to turn the wheel E: this wheel is fixed on a small spindle screwed into the large spindle, which goes through the two blocks, and on which they run.

Supposing fig. 6. to be on the block A, in fig. 7. and to turn to the right, and another piece of the same construction on the block B, with its fires placed so as to turn it to the left; you will find them move very true and fast, by the help of the 3 iron wheels, which serve to regulate their motions, as well as to assist them in turning: let the iron circles in the front of the great wheels be of different diameters, so that when fired there may appear 6 circles. When this piece is fired, all the wheels and illuminations must be lighted at one time.

SECT. VI. *Aquatic Fire-works.*

WORKS that sport in the water are much esteemed by most admirers of fire-works, particularly water-rockets; and as they seem of a very extraordinary nature to those who are unacquainted with this art, they merit a particular explanation.

128. *Water-rockets,*

May be made from 4 oz. to 2 lb. If larger, they are too heavy; so that it will be difficult to make them keep above water without a cork float, which must be tied to the neck of the case; but the rockets will not dive so well with as without floats.

Cases for these are made in the same manner and proportion as sky-rockets, only a little thicker of paper. When you fill those which are drove solid, put in first 1 ladleful of slow fire, then 2 of the proper charge, and on that 1 or 2 ladles of sinking charge, then the proper charge, then the sinking charge again, and so on, till you have filled the case within 3 diameters; then drive on the composition 1 ladleful of clay; through which make a small hole to the charge; then fill the case, within $\frac{1}{4}$ a diameter, with corn-powder, on which turn down 2. or 3 rounds of the case in the inside; then pinch and tie the end very tight; having filled your rockets (according to the above directions), dip their ends in melted rosin or sealing wax, or else secure them well with grease. When you fire those rockets, throw in 6 or 8 at a time; but, if you would have them all sink, or swim, at the same time,

Aquatic Fire-works. time, you must drive them with an equal quantity of composition, and fire them all together.

129. *To make Pipes of Communication, which may be used under Water.*

Pipes for this purpose must be a little thicker of paper than those for land. Having rolled a sufficient number of pipes, and kept them till dry, wash them over with drying oil, and set them to dry; but when you oil them, leave about $1\frac{1}{2}$ inch at each end dry, for joints: if they were oiled all over, when you come to join them, the paste would not stick where the paper is greasy: after the leaders are joined, and the paste dry, oil the joints. These pipes will lie many hours under water, without receiving any damage.

130. *Horizontal Wheels for the Water.*

First get a large wooden bowl without a handle; then have an octagon wheel made of a flat board 18 inches diameter, so that the length of each side will be near 7 inches: in all the sides cut a groove for the cases to lie in. This wheel being made, nail it on the top of the bowl; then take 4-eight oz. cases, filled with a proper charge, each about 6 inches in length. Now, to clothe the wheel with these cases, get some whitish-brown paper, and cut it into slips 4 or 5 inches broad and 7 or 8 long: these slips being pasted all over on one side, take one of the cases, and roll one of the slips of paper about $1\frac{1}{2}$ inch on its end, so that there will remain about $2\frac{1}{2}$ inches of the paper hollow from the end of the case: this case tie on one of the sides of the wheel, near the corners of which must be holes bored, through which you put the packthread to tie the cases: having tied on the first case at the neck and end, put a little meal-powder in the hollow paper; then paste a slip of paper on the end of another case, the head of which put into the hollow paper on the first, allowing a sufficient distance from the tail of one to the head of the other for the pasted paper to bend without tearing: the second case tie on as you did the first: and so on with the rest, except the last, which must be closed at the end, unless it is to communicate to any thing on the top of the wheel, such as fire-pumps or brilliant fires, fixed in holes cut in the wheel, and fired by the last or second case, as the fancy directs: 6, 8, or any number, may be placed on the top of the wheel, provided they be not too heavy for the bowl.

Before you tie on the cases, cut the upper part of all their ends, except the last, a little shelving, that the fire from one may play over the other, without being obstructed by the case. Wheel-cases have no clay drove in their ends, nor pinched, but are always left open, only the last, or those which are not to lead fire, which must be well secured.

131. *Water Mines.*

For these mines you must have a bowl with a wheel on it, made in the same manner as the water-wheel; only in its middle there must be a hole, of the same diameter you design to have the mine. These mines are tin pots, with strong bottoms, and a little more than 2 diameters in length: your mine must be fixed in the hole in the wheel, with its bottom resting on the bowl; then loaded with serpents, crackers, stars, small water-rockets, &c. in the same manner as pots of aigrettes; but in their centre fix a case of Chinese fire, or a small

gerbe, which must be lighted at the beginning of the last case on the wheel. These wheels are to be clothed as usual. *Aquatic Fire-works.*

132. *Fire-globes for the Water.*

Bowls for water-globes must be very large, and the wheels on them of a decagon form: on each side of which nail a piece of wood 4 inches long; and on the outside of each piece cut a groove, wide enough to receive about $\frac{1}{2}$ of the thickness of a 4-oz. case: these pieces of wood must be nailed in the middle of each face of the wheel, and fixed in an oblique direction, so that the fire from the cases may incline upwards: the wheel being thus prepared, tie in each groove a 4-oz. case, filled with a grey charge; then carry a leader from the tail of one case to the mouth of the other.

Globes for these wheels are made of 2 tin hoops, with their edges outwards, fixed one within the other, at right angles. The diameter of these hoops must be somewhat less than that of the wheel. Having made a globe, drive in the centre of a wheel an iron spindle, which must stand perpendicular, and its length 4 or 6 inches more than the diameter of the globe.

This spindle serves for an axis, on which the globe is fixed, which, when done, must stand 4 or 6 inches from the wheel: round one side of each hoop must be foldered little bits of tin, $2\frac{1}{2}$ inches distance from each other; which pieces must be 2 inches in length each, and only fastened at one end, the other ends being left loose, to turn round the small port-fires, and hold them on: these port-fires must be made of such a length as will last out the cases on the wheel. You are to observe, that there need not be any port-fires at the bottom of the globe within 4 inches of the spindle; for, if there were, they would have no effect, but only burn the wheel: all the port-fires must be placed perpendicular from the centre of the globe, with their mouths outwards; and must all be clothed with leaders, so as all to take fire with the second case of the wheel; which cases must burn two at a time, one opposite the other. When two cases of a wheel begin together, two will end together; therefore the two opposite end cases must have their ends pinched and secured from fire. The method of firing such wheels is, by carrying a leader from the mouth of one of the first cases to that of the other; which leader being burnt through the middle, will give fire to both at the same time.

133. *Odoriferous Water Balloons.*

These balloons are made in the same manner as air-balloons, but very thin of paper, and in diameter $1\frac{1}{2}$ inch, with a vent of $\frac{1}{2}$ inch diameter. The shells being made, and quite dry, fill them with any of the following compositions, which must be rammed in tight: these balloons must be fired at the vent, and put into a bowl of water. Odoriferous works are generally fired in rooms.

Composition I. Saltpetre 2 oz. flour of sulphur 1 oz. camphor $\frac{1}{2}$ oz. yellow amber $\frac{1}{2}$ oz. charcoal-dust $\frac{1}{2}$ oz. flour of benjamin or assa odorata $\frac{1}{2}$ oz. all powdered very fine and well mixed.

II. Saltpetre 12 oz. meal-powder 3 oz. frankincense 1 oz. myrrh $\frac{1}{2}$ oz. camphor $\frac{1}{2}$ oz. charcoal 3 oz. all moistened with the oil of spike.

III. Saltpetre 2 oz. sulphur $\frac{1}{2}$ oz. antimony $\frac{1}{2}$ oz. amber $\frac{1}{2}$ oz. cedar raspings $\frac{1}{2}$ oz. all mixed with the oil of roses and a few drops of bergamot.

IV.

Aquatic
Fire-works.

IV. Saltpetre 4 oz. sulphur 1 oz. saw-dust of juniper $\frac{1}{2}$ oz. saw-dust of cypress 1 oz. camphor $\frac{1}{4}$ oz. myrrh 2 drams, dried rosemary $\frac{1}{4}$ oz. cortex elaterii $\frac{1}{2}$ oz. all moistened a little with the oil of roses.

N. B. Water rockets may be made with any of the above compositions, with a little alteration, to make them weaker or stronger, according to the size of the cases.

134. *Water Balloons.*

Having made some thin paper shells, of what diameter you please, fill some with the composition for water balloons, and some after this manner: Having made the vent of the shells pretty large, fill them almost full with water rockets, marrons, squibs, &c. Then put in some blowing powder, sufficient to burst the shells; and afterwards fix in the vent a water-rocket, long enough to reach the bottom of the shell, and its neck to project a little out of the vent; this rocket must be open at the end, to fire the powder in the shell, which will burst the shell, and disperse the small rockets, &c. in the water. When you have well secured the large rocket in the vent of the shell, take a cork float with a hole in its middle, which fit over the head of the rocket, and fasten it to the shell: this float must be large enough to keep the balloon above water.

135. *Water Squibs*

Are generally made of 1-oz. serpent cases seven or eight inches long, filled two thirds with charge, and the remainder bounced. The common method of firing them is this: Take a water-wheel, with a tin mortar in its centre, which load with squibs after the usual method; but the powder in the mortar must be no more than will just throw the squibs out easily into the water: you may place the cases on the wheel either obliquely or horizontally; and on the top of the wheel, round the mortar, fix six cases of brilliant fire perpendicular to the wheel: these cases must be fired at the beginning of the last case of the wheel, and the mortar at the conclusion of the same.

136. *A Sea-fight with small Ships, and to prepare a Fire-ship for it.*

Having procured four or five small ships, of two or three feet in length, (or as many as you design to fight), make a number of small reports, which are to serve for guns. Of these range as many as you please on each side of the upper decks; then at the head and stern of each ship fix a two-ounce case, eight inches long, filled with a slow port-fire receipt; but take care to place it in such a manner that the fire may fall in the water, and not burn the rigging: in these cases bore holes at unequal distances from one another, but make as many in each case as half the number of reports, so that one case may fire the guns on one side, and the other those on the opposite. The method of firing the guns is, by carrying a leader from the holes in the cases to the reports on the decks; you must make these leaders very small, and be careful in calculating the burning of the slow-fire in the regulating cases, that more than two guns be not fired at a time. When you would have a broadside given, let a leader be carried to a cracker, placed on the outside of the ship; which cracker must be tied loose, or the reports will be too slow: in all the ships put artificial guns at the port-holes.

Having filled and bored holes in two port-fires for regulating the guns in one ship, make all the rest ex-

actly the same; then, when you begin the engagement, light one ship first, and set it a sailing, and so on with the rest, sending them out singly, which will make them fire regularly, at different times, without confusion; for the time between the firing of each gun will be equal to that of lighting the slow fires.

The fire-ship may be of any size; and need not be very good, for it is always lost in the action. To prepare a ship for this purpose, make a port-fire equal in size with those in the other ships, and place it at the stern; in every port place a large port-fire, filled with a very strong composition, and painted in imitation of a gun, and let them all be fired at once by a leader from the slow fire, within two or three diameters of its bottom; all along both sides, on the top of the upper deck, lay star-composition about half an inch thick and one broad, which must be wetted with thin size, then primed with meal-powder, and secured from fire by passing paper over it; in the place where you lay this composition, drive some little tacks with flat heads, to hold it fast to the deck: this must be fired just after the sham guns, and when burning will show a flame all round the ship: at the head take up the decks, and put in a tin mortar loaded with crackers, which mortar must be fired by a pipe from the end of the slow fire; the firing of this mortar will sink the ship, and make a pretty conclusion. The regulating port-fire of this ship must be lighted at the same time with the first fighting ship.

Having prepared all the ships for fighting, we shall next proceed with the management of them when on the water. At one end of the pond, just under the surface of the water, fix two running blocks, at what distance you choose the ships should fight; and at the other end of the pond, opposite to each of these blocks, under the water, fix a double block; then on the land, by each of the double blocks, place two small windlasses; round one of them turn one end of a small cord, and the other end put through one of the blocks; then carry it through the single one at the opposite end of the pond, and bring it back through the double block again, and round the other windlafs: to this cord, near the double block, tie as many small strings as half the number of the ships, at what distance you think proper; but these strings must not be more than two feet each: make fast the loose end of each to a ship, just under her bow-sprit; but if tied to the keel, or too near the water, it will upset the ship. Half the ships being thus prepared, near the other double block fix two more windlasses, to which fasten a cord, and to it tie the other half of the ships as before: when you fire the ships, pull in the cord with one of the windlasses, to get all the ships together; and when you have set fire to the first, turn that windlafs which draws them out, and so on with the rest, till they are all out in the middle of the pond; then, by turning the other windlasses, you will draw them back again; by which method you may make them change sides, and tack about backwards and forwards at pleasure. For the fire-ship, fix the blocks and windlasses between the others; so that when she sails out, she will be between the other ships: you must not let this ship advance till the guns at her ports take fire.

137. *To fire Sky-rockets under Water,*

You must have stands made as usual, only the rails must

Aquatic
Fire-works.

Aquatic
Fire-works.

must be placed flat instead of edgewise, and have holes in them for the rocket-sticks to go through; for if they were hung upon hooks, the motion of the water would throw them off: the stands being made, if the pond is deep enough, sink them at the sides so deep, that, when the rockets are in, their heads may just appear above the surface of the water; to the mouth of each rocket fix a leader, which put through the hole with the stick; then a little above the water must be a board, supported by the stand, and placed along one side of the rockets; then the ends of the leaders are turned up through holes made in this board, exactly opposite the rockets. By this means you may fire them singly or all at once. Rockets may be fired by this method in the middle of a pond, by a Neptune, a swan, a water-wheel, or any thing else you choose.

138. *To represent Neptune in his Chariot.*

To do this to perfection, you must have a Neptune (made of wood, or basket work) as big as life, fixed on a float large enough to bear his weight; on which must be two horses heads and necks, so as to seem swimming, as shown by fig. 11. For the wheels of the chariot, there must be two vertical wheels of black fire, and on Neptune's head a horizontal wheel of brilliant fire, with all its cafes, to play upwards. When this wheel is made, cover it with paper or paste-board, cut and painted like Neptune's coronet; then let the trident be made without prongs, but instead of them, fix three cafes of a weak grey charge, and on each horse's head put an eight ounce cafe of brilliant fire, and on the mouth of each fix a short cafe, of the same diameter, filled with the white-flame receipt, enough to last out all the cafes on the wheels: these short cafes must be open at bottom, that they may light the brilliant fires; for the horses eyes put small port-fires, and in each nostril put a small cafe filled half with grey charge, and the rest with port-fire composition.

If Neptune is to give fire to any building on the water; at his first setting out, the wheels of the chariot, and that on his head, with the white flames on the horses heads, and the port-fires in their eyes and nostrils, must all be lighted at once; then from the bottom of the white flames carry a leader to the trident. As Neptune is to advance by the help of a block and cord, you must manage it so as not to let him turn about, till the brilliant fires on the horses and the trident begin; for it is by the fire from the horses (which plays almost upright) that the building, or work, is lighted; which must be thus prepared. From the mouth of the cafe which is to be first fired, hang some loose quick-match to receive the fire from the horses. When Neptune is only to be shown by himself, without setting fire to any other works, let the white flames on the horses be very short, and not to last longer than

one cafe of each wheel, and let two cafes of each wheel burn at a time.

Aquatic
Fire-works.139. *Swans and Ducks in Water.*

If you would have the swans or ducks discharge rockets into the water, they must be made hollow, and of paper, and filled with small water rockets, with some blowing powder to throw them out: but if this is not done, they may be made of wood, which will last many times. Having made and painted some swans, fix them on floats: then in the places where their eyes should be, bore holes two inches deep, inclining downwards, and wide enough to receive a small port-fire; the port-fire cafes for this purpose must be made of brass, two inches long, and filled with a slow bright charge. In the middle of one of these cafes make a little hole; then put the port-fire in the eye-hole of the swan, leaving about half an inch to project out; and in the other eye put another port-fire, with a hole made in it: then in the neck of the swan, within two inches of one of the eyes, bore a hole slantwise, to meet that in the port-fire; in this hole put a leader, and carry it to a water-rocket, that must be fixed under the tail with its mouth upwards. On the top of the head place two 1-oz. cafes, four inches long each, drove with brilliant fire; one of these cafes must incline forwards, and the other backwards: these must be lighted at the same time as the water-rocket; to do which, bore a hole between them in the top of the swan's head, down to the hole in the port-fire, to which carry a leader: if the swan is filled with rockets, they must be fired by a pipe from the end of the water-rocket under the tail. When you set the swan a swimming, light the two eyes.

140. *Water Fire-fountains.*

To make a fire-fountain, you must first have a float made of wood, three feet diameter; then in the middle fix a round perpendicular post, four feet high, and two inches diameter; round this post fix three circular wheels made of thin wood, without any spokes. The largest of these wheels must be placed within two or three inches of the float, and must be nearly of the same diameter. The second wheel must be 2 feet 2 inches diameter, and fixed at two feet distance from the first. The third wheel must be 1 foot 4 inches diameter, and fixed within six inches of the top of the post: the wheels being fixed, take 18 four or eight oz. cafes of brilliant fire, and place them round the first wheel with their mouths outwards, and inclining downwards; on the second wheel place 13 cafes of the same, and in the same manner as those on the first; on the third, place 8 more of these cafes, in the same manner as before, and on the top of the post fix a gerbe; then clothe all the cafes with leaders, so that both they and the gerbe may take fire at the same time. Before you fire this work, try it in the water to see if the float is properly made, so as to keep the fountain upright.

P Y R

PYROTICS, in medicine, caustics, or remedies either actually or potentially hot; and which accordingly will burn the flesh, and raise an eschar. See CAUSTICITY.

PYRRHICHA, in antiquity, a kind of exercise on

P Y R

horseback, or a feigned combat, for the exercise of the cavalry.

It was thus called from its inventor Pyrrichus, or Pyrrhus of Cydonia, who first taught the Cretans to march in measure and cadence to battle, and to ob-

serve

Pyrrhi-
chius
Pyrrus.

serve the pace of the Pyrrhic foot.—Others derive the name from Pyrrhus the son of Achilles, who instituted this exercise at the obsequies of his father.—Aristotle says, that it was Achilles himself who invented it.

The Romans also called it *ludus Trojanus*, “the Trojan game;” and Aulus Gellius, *decurfus*.—It is doubtless this exercise that we see represented on medals by two cavaliers in front running with lancets, and the word *decurfio* in the exergum.

PYRRHICHIUS, in the Greek and Latin poetry, a foot consisting of two syllables, both short;—as, *Deus*.—Among the ancients this foot is also called *periambus*; by others *hegemona*.

PYRRHO, a Greek philosopher, born at Elis in Peloponnesus, flourished about 300 B. C. He was the disciple of Anaxarchus, whom he accompanied as far as India, where he conversed with the Brachmans and Gymnosophists. He had made painting his profession before he devoted himself to the study of philosophy. He established a sect whose fundamental principle was, That there is nothing true or false, right or wrong, honest or dishonest, just or unjust; or that there is no standard of any thing beyond law or custom, and that uncertainty and doubt belong to ever thing. From this continual seeking after truth and never finding it, the sect obtained the name of *Sceptics* or *Pyrrhonians* from the founder, who is said to have acted upon his own principles, and to have carried his scepticism to such a ridiculous extreme, that his friends were obliged to accompany him wherever he went, that he might not be run over by carriages, or fall down precipices. If this was true, it was not without reason that he was ranked among those whose intellects were disturbed by intense study. But it is treated by a modern writer as a mere calumny invented by the dogmatists; and we are strongly inclined to be of his opinion, (see *SCEPTICS*.) Pyrrho died about the 90th year of his age, when his memory was honoured with a statue at Athens, and a monument erected to him in his own country.

PYRRHUS, the name of two kings of EPIRUS. See that article.

PYRUS, the PEAR-TREE: A genus of the pentagynia order, belonging to the icofandria class of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquesid; there are five petals; the fruit is an apple, inferior, quinquelocular, and polyspermous. To this genus Linnæus has joined the apple and quince; but, on account of the remarkable difference between the fruits, the last is treated under the article CYDONIA. The other species are,

1. The communis, or common pear-tree, rises with an upright large trunk, branching 30 or 40 feet high, in some widely around, in others more erectly, and forming a conical head; oval, lanceolated, serrated leaves, and corymbose clusters of white flowers from the sides of the branches, succeeded by large fruit extended at the base. Under this species are comprehended almost endless varieties, all bearing the above description. They bear their flowers and fruit upon spurs, arising from the sides of the branches from two or three years old and upwards; the same branches and spurs continuing fruitful for a great number of

years. The different varieties furnish fruit for use from the beginning of July till the months of May and June, next year; which, according to their times of ripening may be divided into three classes, summer-pears, autumn-pears, and winter-pears. The summer-pears ripen in different sorts from the beginning of July until the middle or end of September, and are generally fit to eat from the tree, or at least do not keep a week or two before they rot. The autumn pears come to their perfection in October, November, and December; some ripening nearly on the tree in October and the beginning of November, others requiring to lie some time in the fruitery, while some will keep two months: but all the winter-pears, though they attain their full growth on the tree by the end of October and in November, yet they do not acquire perfection for eating till from the end of November to April and May. Those of each class have different properties; some being melting, others breaking, some mealy, and some hard and austere, fit only for kitchen uses. As many of the finest sorts were first obtained from France, they are still continued in most catalogues by French names.

2. The malus, or common apple-tree, grows 20 or 30 feet high, having oval serrated leaves, and sessile umbels of whitish red flowers, succeeded by large, roundish, and oblong fruit, concave at the base. The apple is composed of four distinct parts, viz. the pith, the parenchyma, the branchery, and the core. The pith or skin is only a dilatation of the outermost skin or rind of the bark of the branch on which it grew. The parenchyma or pulp, as tender and delicious as it is found, is only a dilatation, or, as Dr Grew calls it, a *swellth* or superbiency of the inner part of the bark of the branch. This appears not only from the visible continuation of the bark from the one through the pedicle or stalk to the other, but also from the structure common to both. The branchery or vessels are only ramifications of the woody part of the branch, sent throughout all the parts of the parenchyma, the greater branches being made to communicate with each other by inosculation of the less. The apple core is originally from the pith of the branch; the sap of which finding room enough in the parenchyma through which to diffuse itself, quits the pith, which by this means hardens into core. The varieties of this species are amazingly great with respect to the differences of the fruit. The botanists contend, that the wilding, or crab-apple of the woods and hedges, is the original kind, and from the seeds of which the cultivated apple was first obtained. The varieties of this last no doubt are multiplied to some hundreds in different places, having been all first accidentally obtained from the seed or kernels of the fruit, and the approved sorts continued and increased by grafting upon crabs or any kind of apple-stocks: but although the number of varieties is very considerable, there are not above 40 or 50 sorts retained in the nurserymens catalogue. These varieties arrive at full growth in successive order from July to the end of October, improve in perfection after being gathered; and several of the winter kinds, in particular, keep good for many months, even till the arrival of apples next summer.

Among these various kinds of apples some are used for the dessert, some for the kitchen, and some for cyder.

Fig. 1.

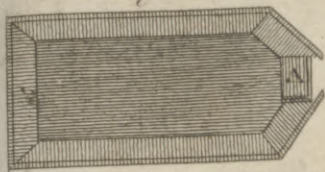


Fig. 2.



Fig. 3.



Fig. 5.

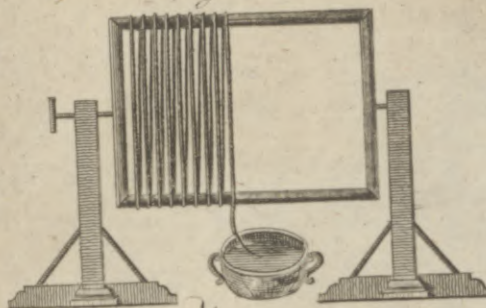


Fig. 6.

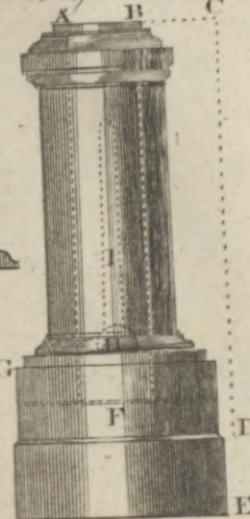


Fig. 7.



Fig. 8.

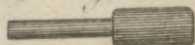


Fig. 9. Fig. 10. Fig. 11.

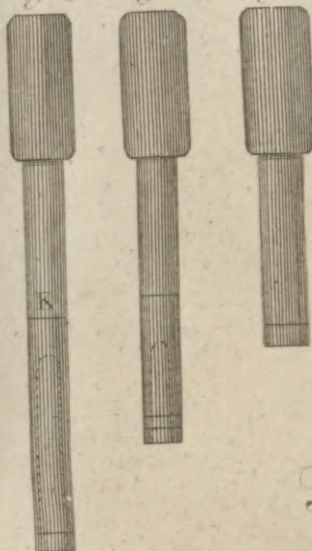


Fig. 12. Fig. 13.

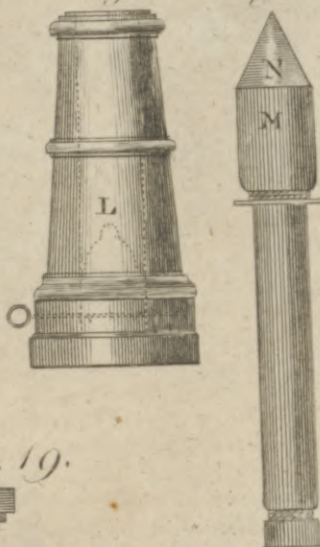


Fig. 14.



Fig. 15.

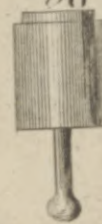


Fig. 16.



Fig. 17.

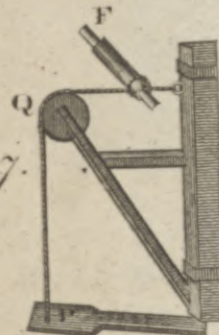


Fig. 19.



Fig. 18.

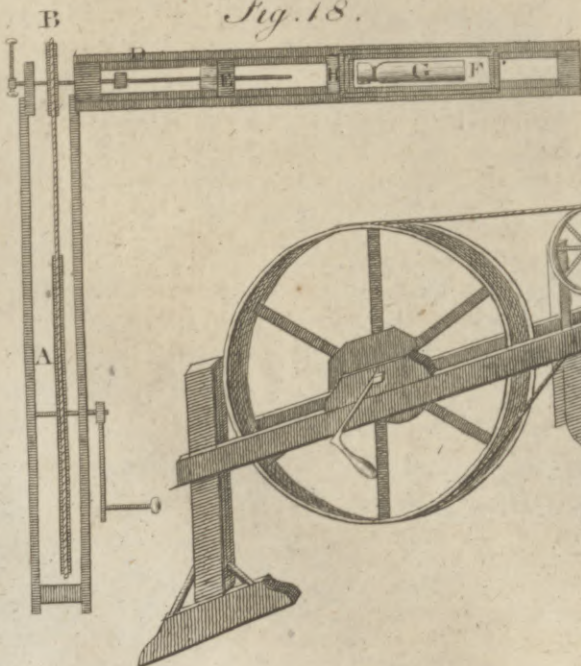


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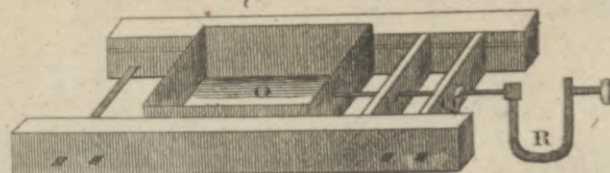


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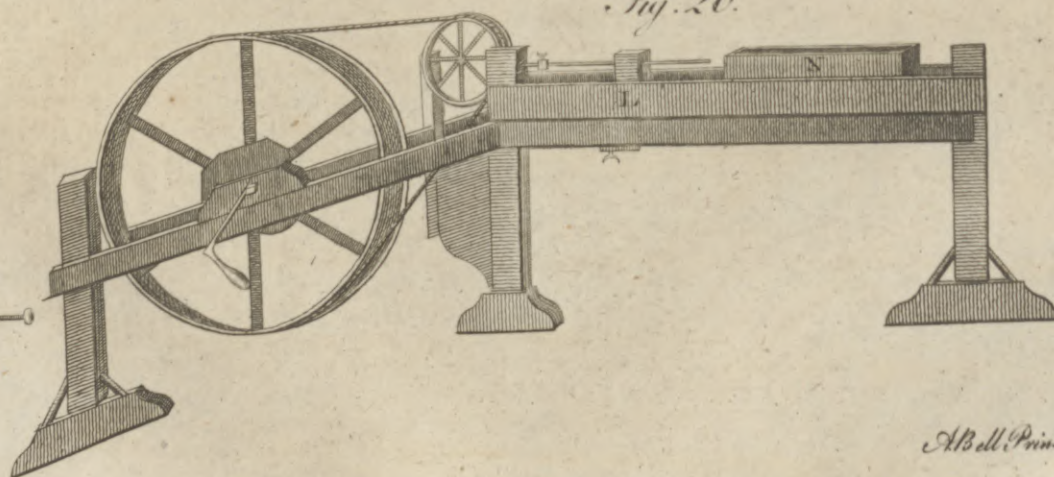


Fig. 21.



Fig. 22.



A Bell Print Works Sculptor & Co.

Fig. 1.

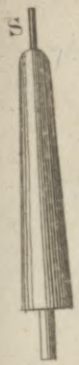


Fig. 2.

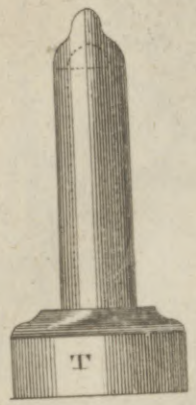


Fig. 3.

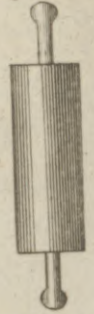
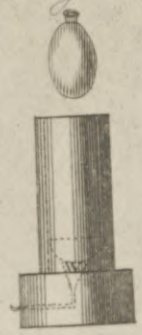


Fig. 4.



Fig. 5.



2. Fig. 9.

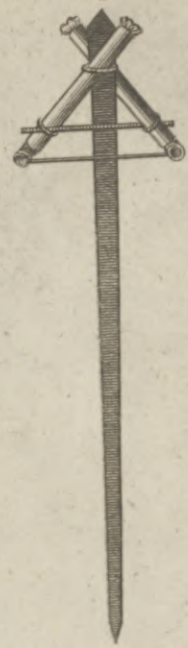


Fig. 10.

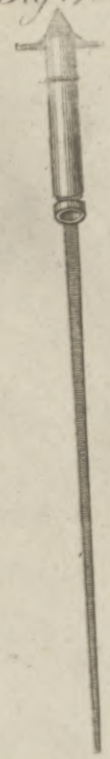


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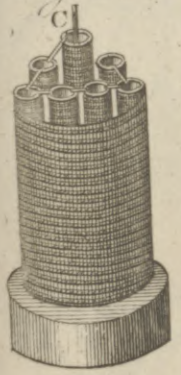


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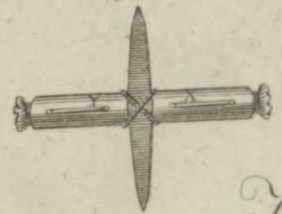


Fig. 9.

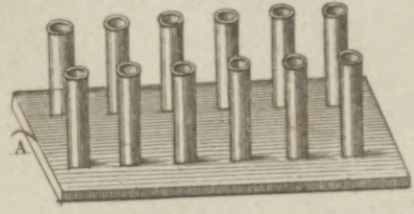


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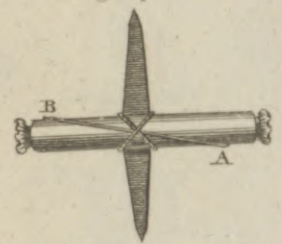


Fig. 11.



Fig. 12.

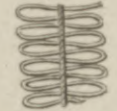


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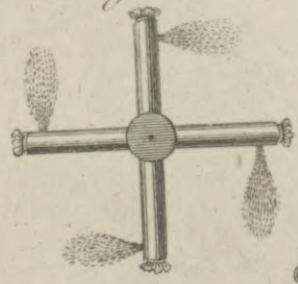


Fig. 13.

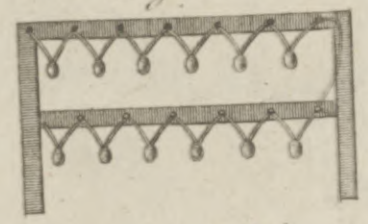


Fig. 18.



Fig. 15.

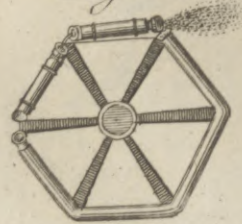


Fig. 16.

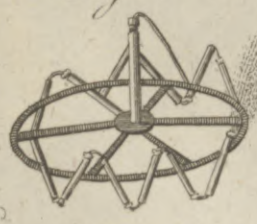
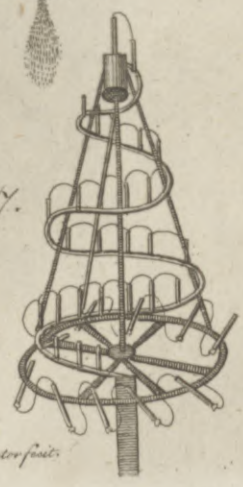


Fig. 17.



A. Bell, Print. Wm. S. Poulter fecit.

PYROTECHNY.

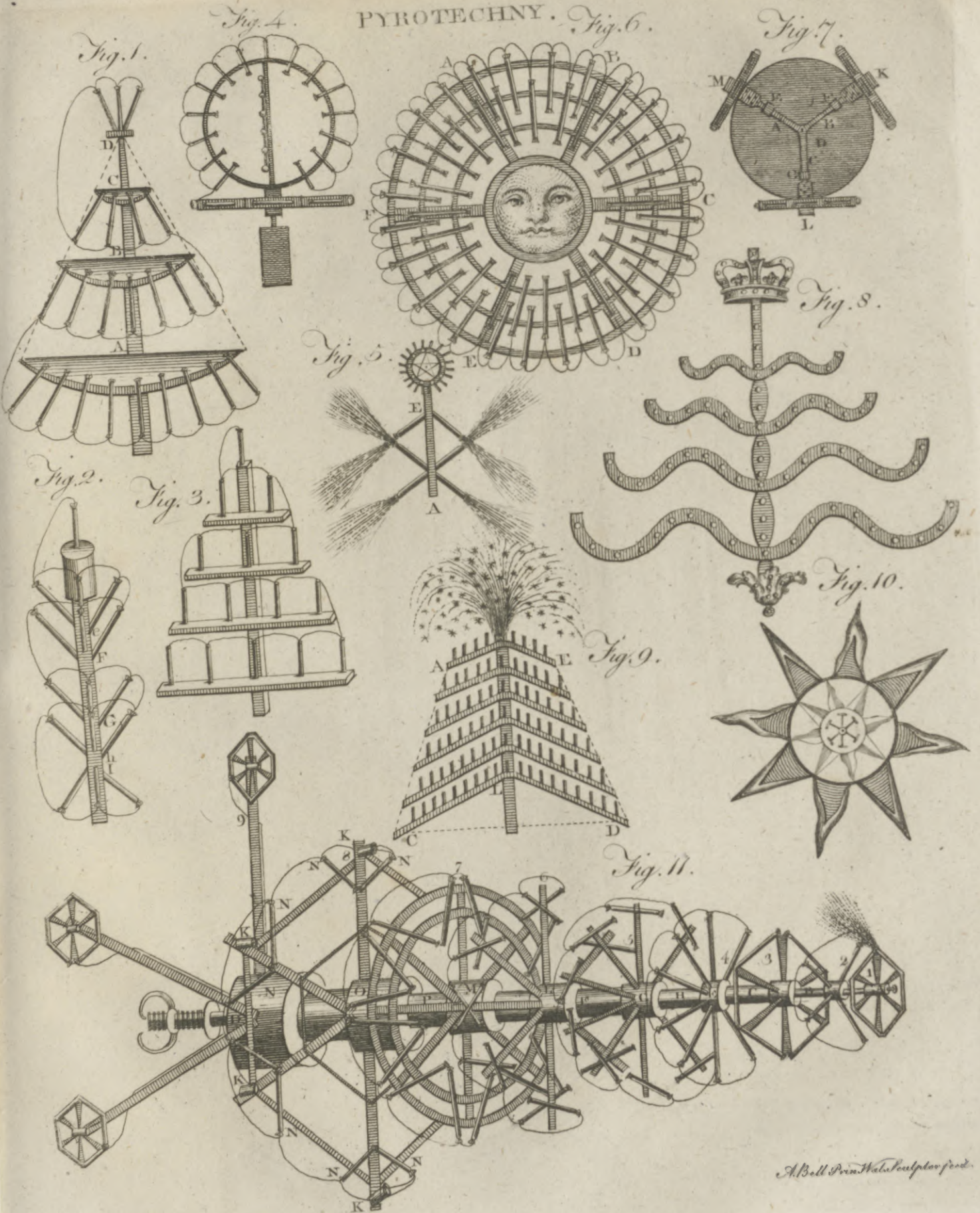


Fig. 1.



Fig. 4.



Fig. 6.

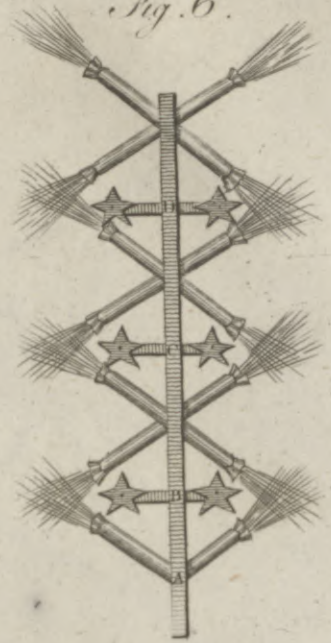


Fig. 2.



Fig. 3.

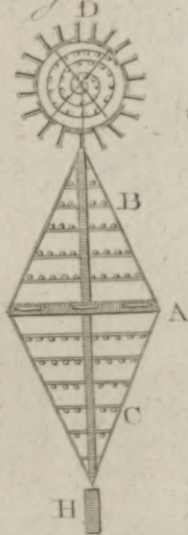


Fig. 5.

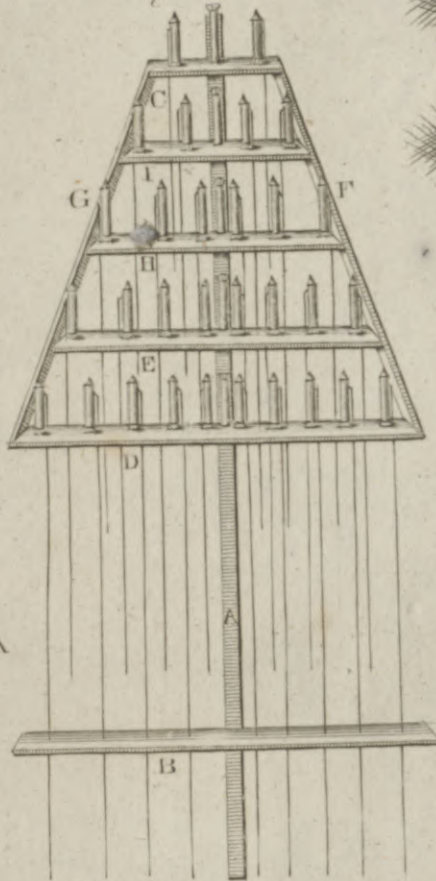


Fig. 7.

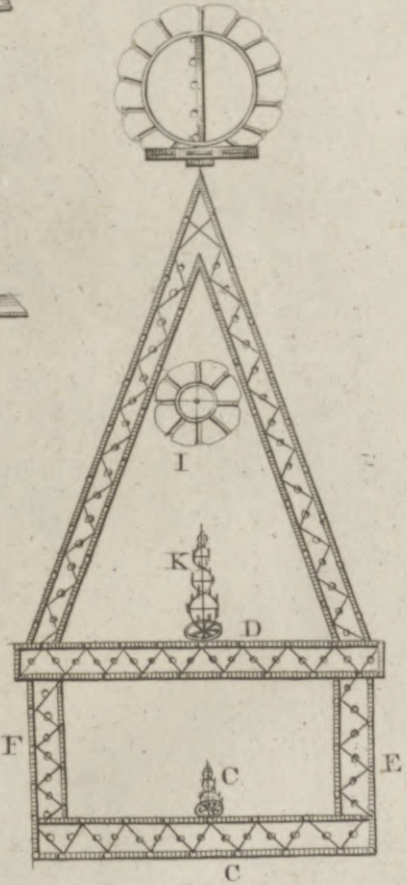


Fig. 8.



Fig. 9.



Fig. 1.



Fig. 2.

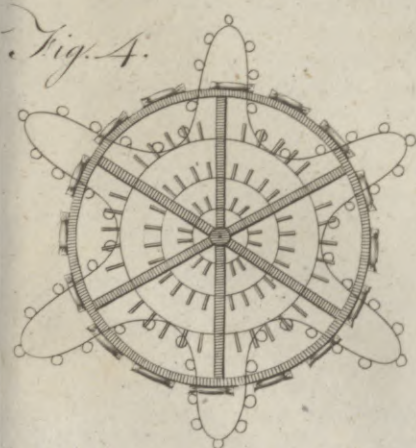
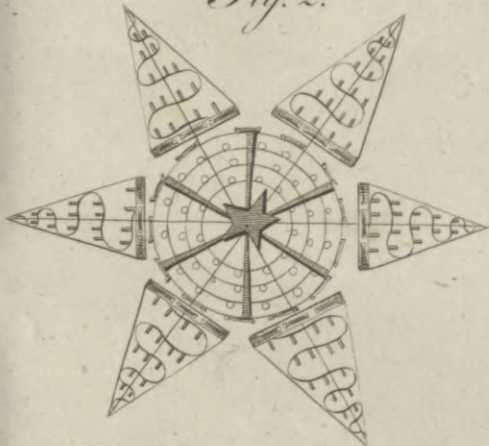


Fig. 6.

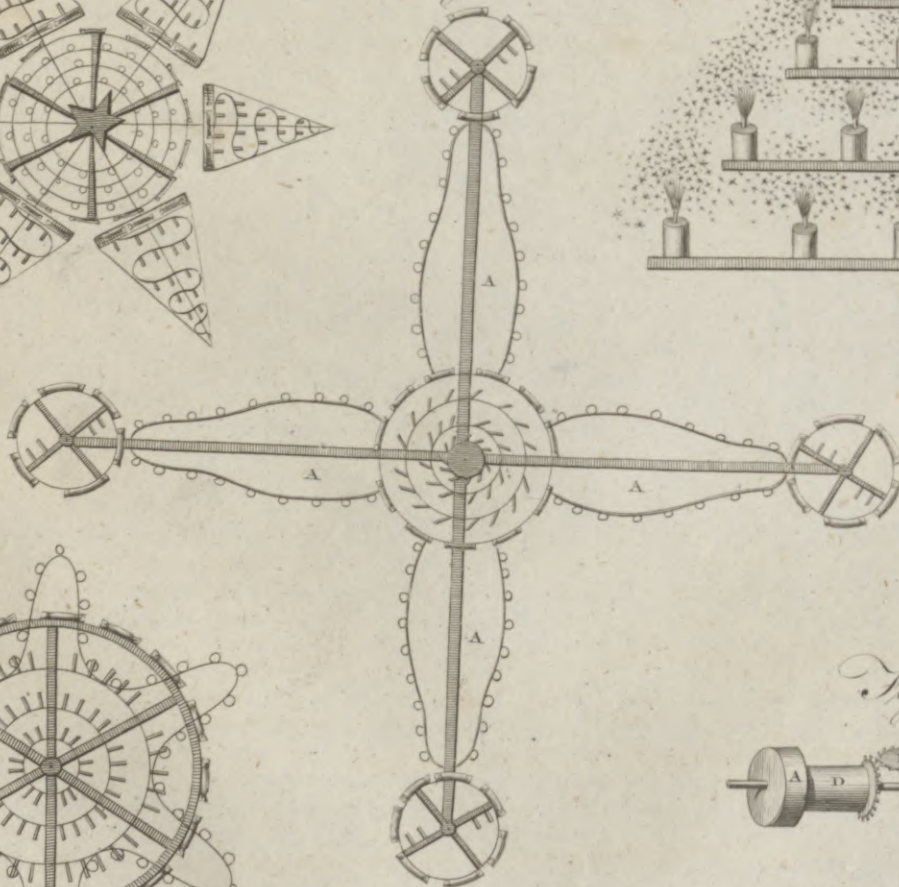


Fig. 3.



Fig. 5.

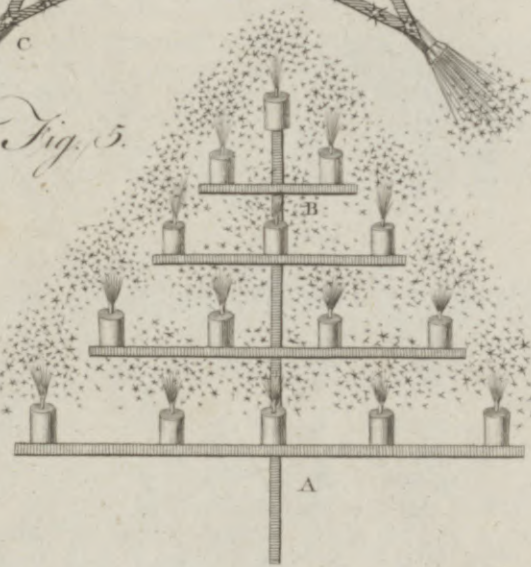
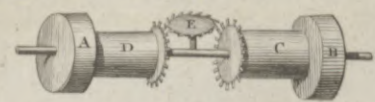


Fig. 7.



Pyrrus,
Pythagoras.

der-making. Those used for the dessert are the following, placed as they successively ripen after one another: The white juncating, the margaret apple, the summer pearmain, the summer queening, the embroidered apple, the golden rennet, the summer white calville, the summer red calville, the silver pippen, the aromatic pippen, *la reinette grise, la haute bonte*, the royal russeting, Wheeler's russet, Sharp's russet, the spine apple, the golden pippen, the nonpareil, the *Papi* or *pomme d'api*. Those for the kitchen use, in the order of their ripening, are these: The codling, the summer marygold, the summer red pearmain, the Holland pippen, the Kentish pippen, the courpendu, Loan's pearmain, the French rennet, the French pippen, the royal russet, the monstrous rennet, the winter pearmain, the *pomme violette*, Spencer's pippen, the stone pippen, and the oaken pippen. These most esteemed for cyder are, the Devonshire royal wilding, the redstreak apple, the whitfour, the Herefordshire under-leaf, and the John apple, or *deux annes*, everlasting hanger, and gennet moyle.

The juice of apples is a menstruum for iron. A solution of iron in the juice of the apples called *golden rennets*, evaporated to a thick consistence, proves an elegant chalybeate, which keeps well.

The best method of preserving apples for winter use, is to let them hang upon the trees until there is danger of frost, to gather them in dry weather, and then to lay them in large heaps to sweat for a month or six weeks. They ought then to be carefully looked over, all which have the least appearance of decay taken out, the sound fruit wiped dry, and packed up in large oil jars, which have been thoroughly scalded and dry, and then stopped close to exclude the air. If this plan is duly observed, the fruit will keep a long time sound, and their flesh remain plump; whereas, when exposed to the air, their skins will shrivel, and their pulp soften.

3. The coronaria, or sweet-scented crab of Virginia, grows 12 or 15 feet high, having angular, serrated leaves, pedunculated umbels of whitish-red, sweet-scented flowers, succeeded by small round crabs, remarkably four and austere. There is one variety, called the *ever-green Virginian crab tree*.

Culture. All the varieties of the pear-tree are hardy, and will succeed in any common soil of a garden or orchard. They are propagated by grafting and budding upon any kind of pear-stocks; also occasionally upon quince-stocks, and sometimes upon white-thorn stocks; but pear-stocks are greatly preferable to all others for general use.—All kinds of apples are propagated in the same manner; using apple-stocks instead of pear-stocks. They will succeed in any common soil of a garden or orchard, and in any free situation except in a low and very moist soil, in which they are apt to canker, and very soon go off. In a friable loam they are generally very successful.

PYTHAGORAS, a celebrated philosopher of antiquity, respecting the time and place of whose birth the learned are much divided. Eratosthenes asserts, that in the 48th Olympiad*, when he was very young, he was a victor at the Olympic games. Hence Dr Bentley† determines the date of his birth to be the 4th year of the 43d Olympiad; whilst Lloyd‡, who denies that the Olympic victor was the same person with the philosopher, places it about the 3d year of the 48th Olympiad. Mr Dodwell§ differs from both, and wishes

to fix the birth of Pythagoras in the 4th year of the 52d Olympiad. Of the arguments of these learned writers, Le Clerc has given a summary in the *Bibliothèque Choisee*, tom. x. p. 81. &c. and from a review of the whole, it would appear that he was not born earlier than the 4th year of the 43d Olympiad, nor later than the 4th year of the 52d; but in what particular year of that period his birth took place, cannot with any degree of certainty be ascertained. It is generally believed that he was born in the island of Samos, and that he flourished about 500 years before Christ, in the time of Tarquin the last king of Rome*. His father Mnesarchus, who is thought by some to have been a lapidary, and by others a merchant of Tyre, appears to have been a man of some distinction, and to have bestowed upon his son the best education.

Jamblicus† relates a number of wonderful stories respecting Pythagoras's descent from Jupiter, his birth, and early life; and represents him even in his youth as a prodigy of wisdom and manly seriousness. But most of these idle tales confuse themselves, afford nothing of importance to be depended upon, and only prove the credulity, carelessness, and prejudice of their author. Of his childhood and early education we know nothing, except that he was first instructed in his own country by Creophilus, and afterwards in Scyrus by Pherecydes (see PHERECYDES). According to the custom of the times he was made acquainted with poetry and music; eloquence and astronomy became his private studies, and in gymnastic exercises he often bore the palm for strength and dexterity. He first distinguished himself in Greece at the Olympic games, where, beside gaining the prize, he is said to have excited the highest admiration by the elegance and dignity of his person, and the brilliancy of his understanding.

Soon after his appearance at these games Pythagoras commenced his travels in quest of knowledge. He first visited Egypt, where, through the interest of Polycrates tyrant of Samos, he obtained the patronage of Amasis king of Egypt, by whose influence, combined with his own assiduity, patience, and perseverance, he at length gained the confidence of the priests; from whom he learned their sacred mysteries, theology, and the whole system of symbolical learning. In Egypt, too, he became acquainted with geometry and the true solar system; and, before he left that country, made himself master of all the learning for which it was so famed among the nations of antiquity.

He afterwards visited Persia and Chaldea, where from the Magi he learnt divination, the interpreting of dreams, and astronomy. He is likewise said to have travelled into India, to have conversed with the Gymnosophists, and to have acquired from them a knowledge of the philosophy and literature of the east; and such was his ardour in the pursuit of science, that in quest of it, we are told by Cicero*, he crossed many seas, and travelled on foot through many barbarous nations.

After Pythagoras had spent many years in gathering information on every subject, especially respecting the nature of the gods, the rites of religion, and the immortality of the human soul, he returned to his native island, and attempted to make his knowledge useful by instituting a school for the instruction of his countrymen. Failing of success in this laudable undertaking, he

Pythagoras.

* *Titus*, lib. iv. cap. i.

† *Vit. Pyth.*, lib. ii. c. 6.

* *De Finib.*, lib. iv. § 29.

An. ante
Chr. 588.
† *Dissert.* on
the *Ep.* of
Plalaris.
‡ *Chron.* of
Pythagoras.
§ *Two Dis-*
tinctions on
the age of
Pythagoras.

Pythago-
ras.

repaired to Delos, where he pretended to receive moral dogmas from the priests of Apollo. He also visited Crete, where he was initiated into the most sacred mysteries of Greece. He went likewise to Sparta and Elis, and again assisted at the Olympic games; where in the public assembly he was saluted with the title of *sophist* or *wise man*, which he declined for one more humble. See PHILOLOGY, n° 1. and PHILOSOPHY n° 1.

He returned to Samos enriched with mythological learning and mysterious rites, and again instituted a school. His mysterious symbols and oracular precepts made this attempt more successful than the former had been; but meeting with some opposition, or being detected in some pious frauds, he suddenly left Samos, retired to Magna Grecia, and settled at Crotona.

Here he founded the Italic sect (see PHILOSOPHY n° 20.); and his mental and personal accomplishments, the fame of his distant travels, and his Olympic crown, soon procured him numerous pupils. His bold and manly eloquence and graceful delivery attracted the most dissolute, and produced a remarkable change in the morals of the people of Crotona. His influence was increased by the regularity of his own example, and its conformity to his precepts. He punctually attended the temples of the gods, and paid his devotions at an early hour; he lived upon the purest and most innocent food, clothed himself like the priests of Egypt, and by his continual purifications and regular offerings appeared to be superior in sanctity to the rest of mankind. He endeavoured to assuage the passions of his scholars with verses and numbers, and made a practice of composing his own mind every morning, by playing on his harp, and singing along with it the pæans of Thales. To avoid the temptations of ease and the seductions of idleness, bodily exercises also made a considerable part of his discipline.

At Crotona he had a public school for the general benefit of the people, in which he taught them their duty, praising virtue and condemning vice; and particularly instructing them in the duties of social life. Beside this, he had a college in his own house, which he denominated *κοινόν*, in which there were two classes of students, viz. *ἀκούοντες*, who were also called *αὐσcultantes* and *ἀκροατικοί*. The former of these were probationers, and were kept under a long examen. A silence of five years was imposed upon them; which Apuleius thinks was intended to teach them modesty and attention; but Clemens Alexandrinus thinks it was for the purpose of abstracting their minds from sensible objects, and inuring them to the pure contemplation of the Deity. The latter class of scholars were called *geminii*, *perfecti*, *mathematici*, and, by way of eminence, *Pythagoreans*. They alone were admitted to the knowledge of the arcana and depths of Pythagoric discipline, and were taught the use of ciphers and hieroglyphic writings.

Clemens observes, that these orders corresponded very exactly to those among the Hebrews: for in the schools of the prophets there were two classes, viz. the sons of the prophets, who were the scholars, and the doctors or masters, who were also called *perfecti*; and among the Levites, the novices or tyros, who had their quinquennial exercises, by way of preparation. Lastly, even among the profelytes there were two or-

ders; *exoterici*, or profelytes of the gate; and *intrinseci* or *perfecti*, profelytes of the covenant. He adds, it is highly probable, that Pythagoras himself had been a profelyte of the gate, if not of the covenant. Gale endeavours to prove that Pythagoras borrowed his philosophy from that of the Jews; to this end producing the authorities of many of the fathers and ancient authors, and even pointing out the tracks and footsteps of Moses in several parts of Pythagoras's doctrine. But we believe the learned author was misled by the Christian Platonists.

The authority of Pythagoras among his pupils was so great, that it was even deemed a crime to dispute his word; and their arguments were considered as infallibly convincing, if they could enforce them by adding, that "the master said so;" an expression which afterwards became proverbial in *jurare in verba magistri*. This influence over his school was soon extended to the world, and even his pupils themselves divided the applause and approbation of the people with their master; and the rulers and legislators of all the principal towns of Greece, Sicily, and Italy, boasted of being the disciples of Pythagoras. To give more weight to his exhortations, as some writers mention, Pythagoras retired into a subterraneous cave, where his mother sent him intelligence of every thing which happened during his absence. After a certain number of months he again re-appeared on the earth with a grim and ghastly countenance, and declared in the assembly of the people that he was returned from hell. From similar exaggerations it has been asserted that he appeared at the Olympic games with a golden thigh, and that he could write in letters of blood whatever he pleased on a looking-glass; and that by setting it opposite to the moon, when full, all the characters which were on the glass became legible on the moon's disc. They also relate, that by some magical words he tamed a bear, stopped the flight of an eagle, and appeared on the same day and at the same instant in the cities of Crotona and Metapontum, &c.

At length his singular doctrines, and perhaps his strenuously asserting the rights of the people against their tyrannical governors, excited a spirit of jealousy, and raised a powerful party against him; which soon became so outrageous as to oblige him to fly for his life. His friends fled to Rhegium; and he himself, after being refused protection by the Locrians, fled to Metapontum, where he was obliged to take refuge in the temple of the muses, and where it is said he died of hunger about 497 years before Christ. Respecting the time, place, and manner of his death, however, there are various opinions, and many think it uncertain when, where, or in what manner, he ended his days. After his death his followers paid the same respect to him as was paid to the immortal gods; they erected statues in honour of him, converted his house at Crotona into a temple of Ceres, appealed to him as a deity, and swore by his name.

Pythagoras married Theano of Crotona, or, according to others, of Crete, by whom he had two sons, Telauges and Mnesarchus, who, after his death, took care of his school. He is said also to have had a daughter called *Damo*.

Whether he left any writings behind him is disputed. It seems probable, however, that he left none, and that

Pythago-
ras.

Pythagoras.

such as went under his name were written by some of his followers. The *golden verses* which Hierocles illustrated with a commentary, have been ascribed to Epicharmus or Empedocles, and contain a brief summary of his popular doctrines. From this circumstance, and from the mysterious secrecy with which he taught, our information concerning his doctrine and philosophy is very uncertain, and cannot always be depended on.

The purpose of philosophy, according to the system of Pythagoras, is to free the mind from incumbrances, and to raise it to the contemplation of immutable truth and the knowledge of divine and spiritual objects. To bring the mind to this state of perfection is a work of some difficulty, and requires a variety of intermediate steps. Mathematical science was with him the first step to wisdom, because it inures the mind to contemplation, and takes a middle course between corporeal and incorporeal beings. The whole science he divided into two parts, *numbers* and *magnitude*; and each of these he subdivided into two others, the former into *arithmetic* and *music*, and the latter into *magnitude at rest* and *in motion*; the former of which comprehends *geometry*, and the latter *astronomy*. Arithmetic he considered as the noblest science, and an acquaintance with numbers as the highest good. He considered numbers as the principles of every thing; and divided them into scientific and intelligible. Scientific number is the production of the powers involved in unity, and its return to the same; number is not infinite, but is the source of that infinite divisibility into equal parts which is the property of all bodies. Intelligible numbers are those which existed in the divine mind before all things. They are the model or archetype of the world, and the cause of the essence of beings. Of the Monad, Duad, Triad, Tetrad, and Decad, various explanations have been given by various authors; but nothing certain or important is known of them. In all probability, numbers were used by Pythagoras as symbolical representations of the first principles and forms of nature, and especially of those eternal and immutable essences which Plato denominated ideas; and in this case the Monad was the simple root from which he conceived numbers to proceed, and as such, analogous to the simple essence of deity; from whence, according to his system, the various properties of nature proceed.

Music followed numbers, and was useful in raising the mind above the dominion of the passions. Pythagoras considered it as a science to be reduced to mathematical principles and proportions, and is said to have discovered the musical chords from the circumstance of several men successively striking with hammers a piece of heated iron upon an anvil. This story Dr Burney* discredits; but allows, from the uniform testimony of writers ancient and modern, that he invented the *harmonical canon* or monochord, (see MONOCHORD.) The music of the spheres, of which every one has heard, was a most fanciful doctrine of Pythagoras. It was produced, he imagined, by the planets striking on the ether through which in their motion they passed; and he considered their musical proportions as exact, and their harmony perfect.

Pythagoras, as we have already seen, learned geometry in Egypt; but by investigating many new theorems, and by digesting its principles, he reduced it to a more regular science. A geometrical point, which he defines

to be a monad, or unity with position, he says corresponds to unity in arithmetic, a line to two, a superficies to three, and a solid to four. He discovered several of the propositions of Euclid; and on discovering the 47th of book 1st, he is said to have offered a hecatomb to the gods; but as he was averse to animal sacrifices, this assertion is surely false. His great progress in astronomical science has been mentioned elsewhere. See ASTRONOMY, n° 11, 22; and PHILOSOPHY, n° 15, 16.

Wisdom, according to Pythagoras, is conversant with those objects which are naturally immutable, eternal, and incorruptible; and its end is to assimilate the human mind to the divine, and to qualify us to join the assembly of the gods. Active and moral philosophy prescribes rules and precepts for the conduct of life, and leads us to the practice of public and private virtue.—On these heads many of his precepts were excellent, and some of them were whimsical and useless. Theoretical philosophy treats of nature and its origin, and is, according to Pythagoras, the highest object of study. It included all the profound mysteries which he taught, of which but little is now known. God he considers as the universal mind, diffused through all things, and the self-moving principle of all things (*αυτοκίνητος τὸν παντὸς*), and of whom every human soul is a portion*. It is very probable, that he conceived of the Deity as a subtle fire, eternal, active, and intelligent; which is not inconsistent with the idea of incorporeality, as the ancients understood that term. This Deity was primarily combined with the chaotic mass of passive matter, but he had the power of separating himself, and since the separation he has remained distinct. The learned Cudworth contends, that Pythagoras maintained a trinity of hypostases in the divine nature, similar to the Platonic triad (see PLATONISM). We cannot say that his arguments appear to have much force; but we think the conclusion which he wishes to establish extremely probable, as Plato certainly drew his doctrine from some of the countries which Pythagoras had visited before him.

Subordinate to the Deity there were in the Pythagorean creed three orders of intelligences, gods, demons, and heroes, of different degrees of excellence and dignity. These, together with the human soul, were considered as emanations from the Deity, the particles of subtle ether assuming a grosser clothing the farther they receded from the fountain. Hierocles defines a hero to be a rational mind united with a luminous body. God himself was represented under the notion of monad, and the subordinate intelligences as numbers derived from and included in unity. Man is considered as consisting of an elementary nature and a divine or rational soul. His soul, a self-moving principle, is composed of two parts; the rational, seated in the brain; and the irrational, including the passions, in the heart. In both these respects he participates with the brutes, whom the temperament of their body, &c. allows not to act rationally. The sensitive soul perishes; the other assumes an ethereal vehicle, and passes to the regions of the dead, till sent back to the earth to inhabit some other body, brutal or human. See MEREMPSYCHOSIS. It was unquestionably this notion which led Pythagoras and his followers to deny themselves the use of flesh, and to be so peculiarly merciful to animals of every description. Some authors, however, say, that flesh and beans, the use of which he also forbade, were prohibited,

Pythagoras.

* Cicero de Senect. § 21.

* History of Music, vol. i. p. 441.

Pythago-
ras.

because he supposed them to have been produced from the same putrified matter, from which, at the creation of the world, man was formed.

Of the symbols of Pythagoras little is known. They have been religiously concealed; and though they have awakened much curiosity, and occasioned many ingenious conjectures, they still appear to us dark and trifling. As a specimen we give the following: "Adore the sound of the whispering wind. Stir not the fire with a sword. Turn aside from an edged tool. Pass not over a balance. Setting out on a journey, turn not back, for the furies will return with you. Breed nothing that hath crooked talons. Receive not a swallow into your house. Look not in a mirror by the light of a candle. At a sacrifice pair not your nails. Eat not the heart or brain. Taste not that which hath fallen from the table. Break not bread. Sleep not at noon. When it thunders touch the earth. Pluck not a crown. Roast not that which has been boiled. Sail not on the ground. Plant not a palm. Breed a cock, but do not sacrifice it, for it is sacred to the sun and moon. Plant mallows in thy garden, but eat them not. Abstain from beans."

The following precepts are more important: "Discourse not of Pythagorean doctrines without light. Above all things govern your tongue. Engrave not the image of God in a ring. Quit not your station without the command of your general. Remember that the paths of virtue and of vice resemble the letter Y. To this symbol Persius refers†, when he says,

*Et tibi quæ Samios diduxit litera ramos,
Surgentem dextro monstravit limite collem.*

There has the Samian Y's instructive make
Pointed the road thy doubtful foot should take;
There warn'd thy raw and yet unpractis'd youth,
To tread the rising right-hand path of truth.

The scantiness and uncertainty of our information respecting Pythagoras, renders a regular and complete account of his life and doctrines impossible. A modern author‡ of profound erudition, pronounces him to have been unquestionably the wisest man that ever lived, if his masters the Egyptian priests must not be excepted. This is saying a great deal too much; but that he was one of the most distinguished philosophers of antiquity, or, as Cicero expresses it, *vir præstanti*

sapientia, appears very evident; and his moral character has never been impeached. The mysterious air which he threw over his doctrines, and the apparent inanity of some of his symbols, have indeed subjected him to the charge of imposture, and perhaps the charge is not wholly groundless: but when we consider the age in which he lived, and the nature of the people with whom he had to deal, who would in all probability have resisted more open innovations, even this will not appear so blameable as at first sight we are apt to think it; and it is worthy of notice, that the worst stories of this kind have come down to us in a very questionable shape, and with much probability appear to be false.

PYTHAGOREANS, a sect of ancient philosophers, so called from being the followers of Pythagoras. See the preceding article.

PYTHIA, the priestess of Apollo at Delphi, by whom he delivered oracles. She was so called from Pythius, a name of that god, which is said to have been given him on account of his victory over the serpent Python.

The Pythia was at first required to be a young girl, but in later times she was a woman of 50 years of age. The first and most famous Pythia was Phemonœ. Oracles were at first delivered by her in hexameter verse. All the pythias were to be pure virgins, and all of them delivered their oracles with great enthusiasm and violent agitations. See ORACLE and DELPHI.

PYTHIAN GAMES, in Grecian antiquity, sports instituted near Delphos in honour of Apollo, on account of his slaying the serpent Python. See APOLLO.—These games, at their first institution, were celebrated only once in nine years; but afterwards every fifth year, from the number of the Parnassian nymphs who came to congratulate Apollo, and to make him presents on his victory. The victor was crowned with garlands.

PYTHON, in fabulous history, a monstrous serpent, produced by the earth after Deucalion's deluge. Juno being exasperated at Latona, who was beloved by Jupiter, commanded this serpent to destroy her; but flying from the pursuit of the monster, she escaped to Delos, where she was delivered of Diana and Apollo; the latter of whom at length destroyed Python with his arrows, in memory of which victory the Pythian games were instituted. See APOLLO.

Pythago-
reans
||
Python.† Sat. III.
36.‡ Ancient
Metaphy-
sics.

Q.

Q, or q, the 16th letter and 12th consonant of our alphabet; but is not to be found either in the Greek, old Latin, or Saxon alphabets; and indeed some would entirely exclude it, pretending that k ought to be used wherever this occurs. However, as it is formed in the voice in a different manner, it is undoubtedly a distinct letter: for, in expressing this sound, the cheeks are contracted, and the lips, particularly the

under one, are put into a canular form, for the passage of the breath.

The q is never sounded alone, but in conjunction with u, as in *quality*, *question*, *quite*, *quote*, &c. and never ends any English word.

As a numeral, Q stands for 500; and with a dash over it, thus Q̄, for 500,000.

Used as an abbreviature, q signifies *quantity*, or *quantum*.

Quab *tum*. Thus, among physicians, *q. pl.* is *quantum placet*, i. e. "as much as you please" of a thing; and *q. f.* is *quantum sufficit*, i. e. "as much as is necessary." *Q. E. D.* among mathematicians, is *quod erat demonstrandum*, i. e. "which was to be demonstrated;" and *Q. E. F.* is *quod erat faciendum*, i. e. "which was to be done." *Q. D.* among grammarians, is *quasi dictum*, i. e. "as if it were said;" or, "as who should say." In the notes of the ancients, *Q* stands for *Quintus*, or *Quintius*; *Q. B. V.* for *quod bene vertat*; *Q. S. S. S.* for *que supra scripta sunt*; *Q. M.* for *Quintus Mutius*, or *quomodo*; *Quint.* for *Quintilius*; and *Quæf.* for *quæstor*.

QUAB, in ichthyology, the name of a Russian fish, which is said to be at first a tadpole, then a frog, and at last a fish. Dr Mounsey, who made many inquiries concerning these pretended changes, considers them all as fabulous. He had opportunity of seeing the fish itself, and found that they spawned like other fishes, and grew in size, without any appearances to justify the report. He adds, that they delight in very clear water, in rivers with sandy or stony bottoms, and are never found in standing lakes, or in rivers passing through marshy or mossy grounds, where frogs choose most to be.

QUABES, are a free people of Africa, inhabiting the southern banks of the river Sestos, and between that and Sierra Leona. They are under the protection of the emperor of Manow.

QUACHA, or *QUAGGA*. See *EQUUS*, n° 5.

QUACHILTO, in ornithology, is the name of a very beautiful Brazilian bird, called also *yacazintli*, and *porphyrio Americanus*. It is of a fine blackish purple colour, variegated with white; its beak is white while young, but becomes red as it grows older, and has a naked space at its basis, resembling in some sort the coot; its legs are of a yellowish green; it lives about the waters, and feeds on fish, yet is a very well tasted bird. It imitates the crowing of a common cock, and makes its music early in the morning.

QUACK, among physicians, the same with empiric. See the article *EMPIRIC*.

QUADI, (Tacitus); a people of Germany, situated to the south-east of the mountains of Bohemia, on the banks of the Danube, and extending as far as the river Marus, or March, running by Moravia, which country they occupied.

QUADRAGESIMA, a denomination given to lent, from its consisting of 40 days. See *LENT*.

QUADRANGLE, in geometry, the same with a quadrilateral figure, or one consisting of four sides and four angles.

QUADRANS, the quarter or fourth part of any thing, particularly the *as*, or pound.

QUADRANS, in English money, the fourth part of a penny. Before the reign of Edward I. the smallest coin was a *sterling*, or penny, marked with a cross; by the guidance of which a penny might be cut into halves for a halfpenny, or into quarters or four parts for farthings; till, to avoid the fraud of unequal cuttings, that king coined halfpence and farthings in distinct round pieces.

QUADRANT, in geometry, the arch of a circle, containing 90°, or the fourth part of the entire periphery.

Sometimes also the space or area, included between this arch and two radii drawn from the centre to each extremity thereof, is called a *quadrant*, or, more properly, a *quadrantal space*, as being a quarter of an entire circle.

QUADRANT, also denotes a mathematical instrument of great use in astronomy and navigation, for taking the altitudes of the sun and stars, as also for taking angles in surveying, &c.

This instrument is variously contrived, and furnished with different apparatus, according to the various uses it is intended for; but they all have this in common, that they consist of a quarter of a circle, whose limb is divided into 90°. Some have a plummet suspended from the centre, and are furnished with sights to look through.

The principal and most useful quadrants are the common surveying quadrant, astronomical quadrant, Adams's quadrant, Cole's quadrant, Gunter's quadrant, Hadley's quadrant, horodictical quadrant, Sutton's or Collins's quadrant, and the sinical quadrant, &c. Of each of which in order.

1. The common surveying quadrant, is made of brass, wood, or any other solid substance; the limb of which is divided into 90°, and each of these farther divided into as many equal parts as the space will allow, either diagonally or otherwise. On one of the semidiameters are fitted two moveable sights; and to the centre is sometimes also fixed a label, or moveable index, bearing two other sights; but in lieu of these last sights there is sometimes fitted a telescope: also from the centre there is hung a thread with a plummet; and on the under side or face of the instrument is fitted a ball and socket, by means of which it may be put into any position. The general use of it is for taking angles in a vertical plane, comprehended under right lines going from the centre of the instrument, one of which is horizontal, and the other is directed to some visible point. But besides the parts already described, there is frequently added on the face, near the centre, a kind of compartment, called the *quadrat*, or *geometrical square*. See *QUADRAT*.

This quadrant may be used in different situations: for observing heights or depths, its plane must be disposed perpendicularly to the horizon; but to take horizontal distances, its plane is disposed parallel thereto. Again, heights and distances may be taken two ways, viz. by means of the fixed sights and plummet, or by the label: As to which, and the manner of measuring angles, see *GEOMETRY*, p. 674, &c.

2. The astronomical quadrant is a large one, usually made of brass, or wooden bars faced with iron plates; having its limb nicely divided, either diagonally or otherwise, into degrees, minutes, and seconds; and furnished with two telescopes, one fixed on the side of the quadrant, and the other moveable about the centre, by means of the screw. There are also dented wheels which serve to direct the instrument to any object or phenomenon.—The use of this curious instrument, in taking observations of the sun, planets, and fixed stars, is obvious; for being turned horizontally upon its axis, by means of the telescope, till the object is seen through the moveable telescope, then the degrees, &c. cut by the index give the altitude required. See *ASTRONOMY*, p. 587, &c.

Quadrant.

Place
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3. Cole's quadrant is a very useful instrument invented by Mr Benjamin Cole. It consists of 6 parts, *viz.* the staff AB (fig. 1.); the quadrantal arch DE; three vanes A, B, C; and the vernier FG. The staff is a bar of wood about two feet long, an inch and a quarter broad, and of a sufficient thickness to prevent it from bending or warping. The quadrantal arch is also of wood; and is divided into degrees, and third-parts of a degree, to a radius of about nine inches; to its extremities are fitted two radii, which meet in the centre of the quadrant by a pin, round which it easily moves. The sight-vane A is a thin piece of brass, almost two inches in height and one broad, placed perpendicularly on the end of the staff A, by the help of two screws passing through its foot. Through the middle of this vane is drilled a small hole, through which the coincidence or meeting of the horizon and solar spot is to be viewed. The horizon vane B is about an inch broad, and two inches and a half high, having a slit cut thro' it of near an inch long and a quarter of an inch broad; this vane is fixed in the centre-pin of the instrument, in a perpendicular position, by the help of two screws passing through its foot, whereby its position with respect to the sight-vane is always the same, their angles of inclination being equal to 45 degrees. The shade-vane C is composed of two brass plates. The one, which serves as an arm, is about four inches and a half long, and three quarters of an inch broad, being pinned at one end to the upper limb of the quadrant by a screw, about which it has a small motion; the other end lies in the arch, and the lower edge of the arm is directed to the middle of the centre-pin; the other plate, which is properly the vane, is about two inches long, being fixed perpendicularly to the other plate, at about half an inch distance from that end next the arch; this vane may be used either by its shade or by the solar spot cast by a convex lens placed therein. And, because the wood-work is often apt to warp or twist, therefore this vane may be rectified by the help of a screw, so that the warping of the instrument may occasion no error in the observation, which is performed in the following manner: Set the line G on the vernier against a degree on the upper limb of the quadrant, and turn the screw on the backside of the limb forward or backward, till the hole in the sight-vane, the centre of the glass, and the sun's spot in the horizon-vane, lie in a right line.

To find the sun's altitude by this instrument: Turn your back to the sun, holding the instrument by the staff with your right hand, so that it be in a vertical plane passing through the sun; apply your eye to the sight-vane, looking through that and the horizon-vane till you see the horizon; with the left hand slide the quadrantal arch upwards, until the solar spot or shade, cast by the shade-vane, fall directly on the spot or slit in the horizon-vane; then will that part of the quadrantal arch, which is raised above G or S (according as the observation respected either the solar spot or shade) show the altitude of the sun at that time. But if the meridian altitude be required, the observation must be continued; and as the sun approaches the meridian, the sea will appear through the horizon-vane, and then is the observation finished; and the degrees and minutes, counted as before, will give the sun's meridian

altitude: or the degrees counted from the lower limb upwards will give the zenith-distance. Quadrant.

4. Adams's quadrant differs only from Cole's quadrant in having an horizontal vane, with the upper part of the limb lengthened; so that the glass, which casts the solar spot on the horizon-vane, is at the same distance from the horizon-vane as the sight-vane at the end of the index.

5. Gunter's quadrant, so called from its inventor Edmund Gunter, besides the usual apparatus of other quadrants, has a stereographical projection of the sphere on the plane of the equinoctial. It has also a kalendar of the months, next to the divisions of the limb.

Use of Gunter's quadrant. 1. To find the sun's meridian altitude for any given day, or the day of the month for any given meridian altitude. Lay the thread to the day of the month in the scale next the limb; and the degree it cuts in the limb is the sun's meridian altitude. Thus the thread, being laid on the 15th of May, cuts $59^{\circ} 30'$, the altitude sought; and, contrarily, the thread, being set to the meridian altitude, shows the day of the month. 2. To find the hour of the day. Having put the bead, which slides on the thread, to the sun's place in the ecliptic, observe the sun's altitude by the quadrant; then, if the thread be laid over the same in the limb, the bead will fall upon the hour required. Thus suppose on the 10th of April, the sun being then in the beginning of Taurus, I observe the sun's altitude by the quadrant to be 36° ; I place the bead to the beginning of Taurus in the ecliptic, and lay the thread over 36° of the limb; and find the bead to fall on the hour-line marked 3 and 9; accordingly the hour is either 9 in the morning or 3 in the afternoon. Again, laying the bead on the hour given, having first rectified or put it to the sun's place, the degree cut by the thread on the limb gives the altitude. Note, the bead may be rectified otherwise, by bringing the thread to the day of the month, and the bead to the hour-line of 12. 3. To find the sun's declination from his place given, and contrariwise. Set the bead to the sun's place in the ecliptic, move the thread to the line of declination, and the bead will cut the degree of declination required. Contrarily, the bead being adjusted to a given declination, and the thread moved to the ecliptic, the bead will cut the sun's place. 4. The sun's place being given, to find his right ascension, or contrarily. Lay the thread on the sun's place in the ecliptic, and the degree it cuts on the limb is the right ascension sought. Contrarily, laying the thread on the right ascension, it cuts the sun's place in the ecliptic. 5. The sun's altitude being given, to find his azimuth, and contrariwise. Rectify the bead for the time, as in the second article, and observe the sun's altitude: bring the thread to the complement of that altitude; thus the bead will give the azimuth sought, among the azimuth lines. 6. To find the hour of the night from some of the five stars laid down on the quadrant. (1.) Put the bead to the star you would observe, and find how many hours it is off the meridian, by article 2. (2.) Then, from the right ascension of the star, subtract the sun's right ascension converted into hours, and mark the difference; which difference, added to the observed hour of the star from the meridian,

Quadrant. dian, shows how many hours the sun is gone from the meridian, which is the hour of the night. Suppose on the 15th of May the sun is in the 4th degree of Gemini, I set the bead to Arcturus; and, observing his altitude, find him to be in the west about 52° high, and the bead to fall on the hour-line of 2 in the afternoon; then will the hour be 11 hours 50 minutes past noon, or 10 minutes short of midnight: for 62, the sun's right ascension, converted into time, makes 4 hours 8 minutes; which, subtracted from 13 hours 58 minutes, the right ascension of Arcturus, the remainder will be 9 hours 50 minutes; which added to 2 hours, the observed distance of Arcturus from the meridian, shows the hour of the night to be 11 hours 50 minutes.

The mural quadrant has already been described under the article ASTRONOMY, n^o 497. It is a most important instrument, and has of late been much improved by Mr Ramsden, who has distinguished himself by the accuracy of his divisions, and by the manner in which he finishes the planes by working them in a vertical position. He places the plumb-line behind the instrument, that there may be no necessity for removing it when we take an observation near the zenith. His manner of suspending the glass, and that of throwing light on the object-glass and on the divisions at the same time, are new, and improvements that deserve to be noticed. Those of eight feet, which he has made for the observatories of Padua and Vilna, have been examined by Dr Maskelyne; and the greatest error does not exceed two seconds and a half. That of the same size for the observatory of Milan is in a very advanced state. The mural quadrant, of six feet, at Blenheim, is a most admirable instrument. It is fixed to four pillars, which turn on two pivots, so that it may be put to the north and to the south in one minute. It was for this instrument Mr Ramsden invented a method of rectifying the arc of 90 degrees, on which an able astronomer had started some difficulties; but by means of an horizontal line and a plumb-line, forming a kind of cross, without touching the circle, he showed him that there was not an error of a single second in the 90 degrees; and that the difference was occasioned by a mural quadrant of Bird, in which the arc of 90 degrees was too great by several seconds, and which had never been rectified by so nice a method as that of Mr Ramsden.

But the quadrant is not the instrument which stands highest in Mr Ramsden's opinion; it is the complete circle: and he has demonstrated to M. de la Lande, that the former must be laid aside, if we would arrive at the utmost exactness of which an observation is capable. His principle reasons are: 1. The least variation in the centre is perceived by the two diametrically opposite points. 2. The circle being worked on the turn, the surface is always of the greatest accuracy, which it is impossible to obtain in the quadrant. 3. We may always have two measures of the same arc, which will serve for the verification of each other. 4. The first point of the division may be verified every day with the utmost facility. 5. The dilatation of the metal is uniform, and cannot produce any error. 6. This instrument is a meridian glass at the same time. 7. It also becomes a moveable azimuth circle by adding an hori-

zontal circle beneath its axis, and then gives the refractions independent of the mensuration of time.

6. Hadley's quadrant is an instrument of vast utility both in navigation and practical astronomy. It derives its name from Mr Hadley, who first published an account of it, though the first thought originated with the celebrated Dr Hooke, and was completed by Sir Isaac Newton (see ASTRONOMY, n^o 32. and also n^o 17. and 22.) The utility of this quadrant arises from the accuracy and precision with which it enables us to determine the latitude and longitude; and to it is navigation much indebted for the very great and rapid advances it has made of late years. It is easy to manage, and of extensive use, requiring no peculiar steadiness of hand, nor any such fixed basis as is necessary to other astronomical instruments. It is used as an instrument for taking angles in maritime surveying, and with equal facility at the mast head as upon the deck, by which its sphere of observation is much extended; for supposing many islands to be visible from the mast head, and only one from deck, no useful observation can be made by any other instrument. But by this, angles may be taken at the mast head from the one visible object with great exactness; and further, taking angles from heights, as hills, or a ship mast's head, is almost the only way of exactly describing the figure and extent of shoals.

It has been objected to the use of this instrument for surveying, that it does not measure the horizontal angles, by which alone a plan can be laid down. This objection, however true in theory, may be reduced in practice by a little caution; and Mr Adams has given very good directions for doing so.

Notwithstanding, however, the manifest superiority of this instrument over those that were in use at the time of its publication, it was many years before the sailors could be persuaded to adopt it, and lay aside their imperfect and inaccurate instruments; so great is the difficulty to remove prejudice, and emancipate the mind from the slavery of opinion. No instrument has undergone, since the original invention, more changes than the quadrant of Hadley; of the various alterations, many had no better foundation than the caprice of the makers, who by these attempts have often rendered the instrument more complicated in construction, and more difficult in use, than it was in its original state.

It is an essential property of this instrument, derived from the laws of reflection, that half degrees on the arch answer to whole ones in the angles measured: hence an octant, or the eighth part of a circle, or 45 degrees on the arch, serves to measure 90 degrees; and sextants will measure an angular distance of 120 degrees, tho' the arch of the instrument is no more than 60 degrees. It is from this property that foreigners term that instrument an *octant*, which we usually call a *quadrant*, and which in effect it is. This property reduces indeed considerably the bulk of the instrument: but at the same time it calls for the utmost accuracy in the divisions, as every error on the arch is doubled in the observation.

Another essential, and indeed an invaluable, property of this instrument, whereby it is rendered peculiarly advantageous in marine observations, is, that it is not liable

Quadrant. liable to be disturbed by the ship's motion; for provided the mariner can see distinctly the two objects in the field of his instrument, no motion nor vacillation of the ship will injure his observation.

Thirdly, the errors to which it is liable are easily discovered and readily rectified, while the application and use of it is facile and plain.

To find whether the two surfaces of any one of the reflecting glasses be parallel, apply your eye at one end of it, and observe the image of some object reflected very obliquely from it; if that image appears single, and well-defined about the edges, it is a proof that the surfaces are parallel; on the contrary, if the edge of the reflected images appear misted, as if it threw a shadow from it, or separated like two edges, it is a proof that the two surfaces of the glass are inclined to each other: if the image in the speculum, particularly if that image be the sun, be viewed through a small telescope, the examination will be more perfect.

To find whether the surface of a reflecting glass be plane. Choose two distant objects, nearly on a level with each other: hold the instrument in an horizontal position, view the left hand object directly through the transparent part of the horizon-glass, and move the index till the reflected image of the other is seen below it in the silvered part; make the two images unite just at the line of separation, then turn the instrument round slowly on its own plane, so as to make the united images move along the line of separation of the horizon-glass. If the images continue united without receding from each other, or varying their respective position, the reflecting surface is a good plane.

To find if the two surfaces of a red or darkening glass are parallel and perfectly plane. This must be done by means of the sun when it is near the meridian, in the following manner: hold the sextant vertically, and direct the sight to some object in the horizon, or between you and the sky, under the sun; turn down the red glass and move the index till the reflected image of the sun is in contact with the object seen directly: fix then the index, and turn the red glass round in its square frame; view the sun's image and object immediately, and if the sun's image is neither raised nor depressed, but continues in contact with the object below, as before, then the surfaces of the darkening glass are true.

For a more particular description of Hadley's quadrant, and the mode of using it, see NAVIGATION, Book II. Chap. I.

This instrument has undergone several improvements since its first invention, and among these improvers must be ranked Mr Ramsden. He found that the essential parts of the quadrant had not a sufficient degree of solidity; the friction at the centre was too great, and in general the alidada might be moved several minutes without any change in the position of the mirror; the divisions were commonly very inaccurate, and Mr Ramsden found that Abbé de la Caille did not exceed the truth in estimating at five minutes the error to which an observer was liable in taking the distance between the moon and a star; an error capable of producing a mistake of 50 leagues in the longitude. On this account Mr Ramsden changed the principle of construc-

tion of the centre, and made the instrument in such a Quadrant. manner as never to give an error of more than half a minute; and he has now brought them to such a degree of perfection as to warrant it not more than six seconds in a quadrant of fifteen inches. Since the time of having improved them, Mr Ramsden has constructed an immense number; and in several which have been carried to the East Indies and America, the deficiency has been found no greater at their return than it had been determined by examinations before their being taken out. Mr Ramsden has made them from 15 inches to an inch and a half, in the latter of which the minutes are easily distinguishable; but he prefers for general use those of 10 inches, as being more easily handled than the greater, and at the same time capable of equal accuracy. See SEXTANT.

A great improvement was also made in the construction of this quadrant by Mr Peter Dollond, famous for his invention of achromatic telescopes. The glasses of the quadrants should be perfect planes, and have their surfaces perfectly parallel to one another. By a practice of several years, Mr Dollond found out methods of grinding them of this form to great exactness; but the advantage which should have arisen from the goodness of the glasses was often defeated by the index-glass being bent by the frame which contains it. To prevent this, Mr Dollond contrived the frame so that the glass lies on three points, and the part that presses on the front of the glass has also three points opposite to the former. These points are made to confine the glass by three screws at the back, acting directly opposite to the points between which the glass is placed. The principal improvements, however, are in the methods of adjusting the glasses, particularly for the back-observation. The method formerly practised for adjusting that part of the instrument by means of the opposite horizons at sea, was attended with so many difficulties that it was scarce ever used: for so little dependence could be placed on the observations taken this way, that the best Hadley's sextants made for the purpose of observing the distances of the moon from the sun or fixed stars have been always made without the horizon-glass for the back-observation; for want of which, many valuable observations of the sun and moon have been lost, when their distance exceeded 120 degrees. To make the adjustment of the back-observation easy and exact, he applied an index to the back horizon-glass, by which it may be moved in a parallel position to the index-glass, in order to give it the two adjustments in the same manner as the fore-horizon-glass is adjusted. Then, by moving the index to which the back-horizon-glass is fixed exactly 90 degrees (which is known by the divisions made for that purpose), the glass will thereby be set at right angles to the index-glass, and will be properly adjusted for use; and the observations may be made with the same accuracy by this as by the fore-observation. To adjust the horizon-glasses in the perpendicular position to the plane of the instrument, he contrived to move each of them by a single screw, which goes through the frame of the quadrant, and is turned by means of a milled head at the back; which may be done by the observer while he is looking at the object. To these improvements also

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Quadrant. he added a method invented by Mr Maskelyne, of placing darkening-glasses behind the horizon-glasses. These, which serve for darkening the object seen by direct vision, in adjusting the instrument by the sun or moon, he placed in such a manner as to be turned behind the fore horizon-glass, or behind the back horizon-glass: there are three of these glasses of different degrees of darkness.

We have been the more particular in our description and use of Hadley's quadrant, as it is undoubtedly the best hitherto invented.

Plate
ccccxxvii.

7. Horodistical quadrant, a pretty commodious instrument, so called from its use in telling the hour of the day.—Its construction is this: From the centre of the quadrant, C, fig. 3. whose limb AB is divided into 90°, describe seven concentric circles at intervals at pleasure; and to these add the signs of the zodiac, in the order represented in the figure. Then applying a ruler to the centre C and the limb AB, mark upon the several parallels the degrees corresponding to the altitude of the sun when therein, for the given hours; connect the points belonging to the same hour with a curve line, to which add the number of the hour. To the radius CA fit a couple of sights, and to the centre of the quadrant C tie a thread with a plummet, and upon the thread a bead to slide. If now the thread be brought to the parallel wherein the sun is, and the quadrant directed to the sun, till a visual ray pass through the sights, the bead will show the hour; for the plummet, in this situation, cuts all the parallels in the degrees corresponding to the sun's altitude. Since the bead is in the parallel which the sun describes, and through the degrees of altitude to which the sun is elevated every hour there pass hour-lines, the bead must show the present hour. Some represent the hour-lines by arches of circles, or even by straight lines, and that without any sensible error.

8. Sutton's or Collins's quadrant (fig. 4.) is a stereographic projection of one quarter of the sphere between the tropics, upon the plane of the ecliptic, the eye being in its north-pole: it is fitted to the latitude of London. The lines running from the right hand to the left are parallels of altitude; and those crossing them are azimuths. The lesser of the two circles, bounding the projection, is one fourth of the tropic of Capricorn; the greater is one fourth of that of Cancer. The two ecliptics are drawn from a point on the left edge of the quadrant, with the characters of the signs upon them; and the two horizons are drawn from the same point. The limb is divided both into degrees and time; and, by having the sun's altitude, the hour of the day may be found here to a minute. The quadrantal arches next the centre contain the kalendar of months; and under them, in another arch, is the sun's declination. On the projection are placed several of the most noted fixed stars between the tropics; and the next below the projection is the quadrant and line of shadows.—To find the time of the sun's rising or setting, his amplitude, his azimuth, hour of the day, &c. by this quadrant: lay the thread over the day and the month, and bring the bead to the proper ecliptic, either of summer or winter, according to the season, which is called *rectifying*; then, moving the thread, bring the bead to the horizon, in which case the thread will cut the limb in the time of the sun's rising or set-

ting before or after six; and at the same time the bead will cut the horizon in the degrees of the sun's amplitude.—Again, observing the sun's altitude with the quadrant, and supposing it found 45° on the fifth of May, lay the thread over the fifth of May, bring the bead to the summer ecliptic, and carry it to the parallel of altitude 45°; in which case the thread will cut the limb at 55° 15', and the hour will be seen among the hour-lines to be either 41' past nine in the morning, or 19' past two in the afternoon.—Lastly, the bead among the azimuths shows the sun's distance from the south 50° 41'. But note, that if the sun's altitude be less than what it is at six o'clock, the operation must be performed among those parallels above the upper horizon; the bead being rectified to the winter ecliptic.

9. Sinical quadrant (fig. 5.) consists of several concentric quadrantal arches, divided into eight equal parts by radii, with parallel right lines crossing each other at right angles. Now any one of the arches, as BC, may represent a quadrant of any great circle of the sphere, but is chiefly used for the horizon or meridian. If then BC be taken for a quadrant of the horizon, either of the sides, as AB, may represent the meridian; and the other side, AC, will represent a parallel, or line of east and west: and all the other lines, parallel to AB, will be also meridians; and all those parallel to AC, east and west lines, or parallels.—Again, the eight spaces into which the arches are divided by the radii, represent the eight points of the compass in a quarter of the horizon; each containing 11° 15'. The arch BC is likewise divided into 90, and each degree subdivided into 12, diagonal-wise. To the centre is fixed a thread, which, being laid over any degree of the quadrant, serves to divide the horizon.

If the sinical quadrant be taken for a fourth part of the meridian, one side thereof, AB, may be taken for the common radius of the meridian and equator; and then the other, AC, will be half the axis of the world. The degrees of the circumference, BC, will represent degrees of latitude; and the parallels to the side AB, assumed from every point of latitude to the axis AC, will be radii of the parallels of latitude, as likewise the sine complement of those latitudes.

Suppose, then, it be required to find the degrees of longitude contained in 83 of the lesser leagues in the parallel of 48°; lay the thread over 48° of latitude on the circumference, and count thence the 83 leagues on AB, beginning at A; this will terminate in H, allowing every small interval four leagues. Then tracing out the parallel HE, from the point H to the thread; the part AE of the thread shows that 125 greater or equinoctial leagues make 6° 15'; and therefore that the 83 lesser leagues AH, which make the difference of longitude of the course, and are equal to the radius of the parallel HE, make 6° 15' of the said parallel.

If the ship sails an oblique course, such course, besides the north and south greater leagues, gives lesser leagues easterly and westerly, to be reduced to degrees of longitude of the equator. But these leagues being made neither on the parallel of departure, nor on that of arrival, but in all the intermediate ones, we must find a mean proportional parallel between them. To find this, we have on the instrument a scale of cross latitudes. Suppose then it were required to find a

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Quadrat.

mean parallel between the parallels of 40° and 60° ; with your compasses take the middle between the 40th and 60th degree on this scale: the middle point will terminate against the 51st degree, which is the mean parallel required.

The principal use of the sinical quadrant is to form triangles upon, similar to those made by a ship's way with the meridians and parallels; the sides of which triangles are measured by the equal intervals between the concentric quadrants and the lines N and S, E and W: and every fifth line and arch is made deeper than the rest. Now, suppose a ship to have sailed 150 leagues north-east, one fourth north, which is the third point, and makes an angle of $33^{\circ} 44'$ with the north part of the meridian: here are given the course and distance sailed, by which a triangle may be formed on the instrument similar to that made by the ship's course; and hence the unknown parts of the triangle may be found. Thus, supposing the centre A to represent the place of departure; count, by means of the concentric circles along the point the ship sailed on, viz. AD, 150 leagues: then in the triangle AED, similar to that of the ship's course, find AE = difference of latitude, and DE = difference of longitude, which must be reduced according to the parallel of latitude come to.

10. Gunner's quadrant (fig. 6.), sometimes called *gunner's square*, is that used for elevating and pointing cannon, mortars, &c. and consists of two branches either of brass or wood, between which is a quadrantal arch divided into 90 degrees, beginning from the shorter branch, and furnished with a thread and plummet, as represented in the figure. — The use of the gunner's quadrant is extremely easy; for if the longest branch be placed in the mouth of the piece, and it be elevated till the plummet cut the degree necessary to hit a proposed object, the thing is done. Sometimes on one of the surfaces of the long branch are noted the division of diameters and weights of iron bullets, as also the bores of pieces.

QUADRANT of Altitude, is an appendage of the artificial globe, consisting of a lamina, or slip of brass, the length of a quadrant of one of the great circles of the globe, and graduated. At the end, where the division terminates, is a nut rivetted on, and furnished with a screw, by means whereof the instrument is fitted on the meridian, and moveable round upon the rivet to all points of the horizon. — Its use is to serve as a scale in measuring of altitudes, amplitudes, azimuths, &c. See ASTRONOMY, n^o 379, &c.

QUADRANTAL, in antiquity, the name of a vessel in use among the Romans for the measuring of liquids. It was at first called *ampbora*; and afterwards *quadrantal*, from its form, which was square every way like a die. Its capacity was 80 libræ, or pounds of water, which made 48 sextaries, two urnæ, or eight congi.

QUADRAT, a mathematical instrument, called also a *Geometrical Square*, and *Line of Shadows*: it is frequently an additional member on the face of the common quadrant, as also on those of Gunter's and Sutton's quadrants. See GEOMETRY, p. 672. and Plate CCXVII. fig. 1—5.

QUADRAT, in printing, a piece of metal used to fill up the void spaces between words, &c. There are qua-

drats of different sizes; as m-quadrats, n-quadrats, &c. which are respectively of the dimensions of these letters, only lower, that they may not receive the ink.

QUADRATIC EQUATIONS, in algebra, those wherein the unknown quantity is of two dimensions, or raised to the second power. See ALGEBRA.

QUADRATRIX, in geometry, a mechanical line, by means whereof we can find right lines equal to the circumference of circles, or other curves, and their several parts.

QUADRATURE, in geometry, denotes the squaring, or reducing a figure to a square. Thus, the finding of a square, which shall contain just as much surface or area as a circle, an ellipsis, a triangle, &c. is the quadrature of a circle, ellipsis, &c. The quadrature, especially among the ancient mathematicians, was a great postulatam. The quadrature of rectilinear figures is easily found, for it is merely the finding their areas or surfaces i. e. their squares; for the squares of equal areas are easily found by only extracting the roots of the areas thus found. See GEOMETRY, Part II. chap. 3. The quadrature of curvilinear spaces is of more difficult investigation; and in this respect extremely little was done by the ancients, except the finding the quadrature of the parabola by Archimedes. In 1657, Sir Paul Neil, Lord Brouncker, and Sir Christopher Wren, geometrically demonstrated the equality of some curvilinear spaces to rectilinear spaces; and soon after the like was proved both at home and abroad of other curves, and it was afterwards brought under an analytical calculus; the first specimen of which was given to the public in 1688 by Mercator, in a demonstration of Lord Brouncker's quadrature of the hyperbola, by Dr Wallis's reduction of a fraction into an infinite series by division. Sir Isaac Newton, however, had before discovered a method of attaining the quantity of all quadruple curves analytically by his fluxions before 1668. It is disputed between Sir Christopher Wren and Mr Huygens which of them first discovered the quadrature of any determinate cycloidal space. Mr Leibnitz afterwards found that of another space; and in 1669 Bernoulli discovered the quadrature of an infinity of cycloidal spaces both segments and sectors, &c. See GEOMETRY, Part II. chap. 3. prop. 33.; and FLUXIONS, p. 314.

QUADRATURE, in astronomy, that aspect of the moon when she is 90° distant from the sun; or when she is in a middle point of her orbit, between the points of conjunction and opposition, namely, in the first and third quarters. See ASTRONOMY, n^o 320, &c.

QUADRATUS, in anatomy, a name given to several muscles on account of their square figure. See ANATOMY, *Table of the Muscles*.

QUADREL, in building, a kind of artificial stone, so called from its being perfectly square. The quadrels are made of a chalky earth, &c. and dried in the shade for two years. These were formerly in great request among the Italian architects.

QUADRIGA, in antiquity, a car or chariot drawn by four horses. On the reverses of medals, we frequently see the emperor or Victory in a quadriga, holding the reins of the horses; whence these coins are, among the curious, called *nummi quadrigati*, and *victoriati*.

Quadratic
||
Quadriga.

Quadrilate-
ral,
Quadrille.

QUADRILATERAL, in geometry, a figure whose perimeter consists of four sides and four angles; whence it is also called a *quadrangular figure*.

QUADRILLE, a little troop or company of cavaliers, pompously dressed, and mounted for the performance of carousals, jousts, tournaments, runnings at the ring, and other gallant divertisements.

QUADRILLE, a game played by four persons, with 40 cards; which are the remains of a pack, after the four tens, nines, and eights are discarded; these are dealt three and three, and one round four, to the right hand player; and the trump is made by him that plays with or without calling, by naming spades, clubs, diamonds, or hearts, and the suit named is trumps. If the person who names the trump should mistake, and say spades instead of clubs, or if he name two suits, the first named is the trump.

In this game the order of the cards, according to their natural value, is as follows: of hearts and diamonds, *king, queen, knave, ace, deuce, three, four, five, six, seven*; in all 10; of spades and clubs, *king, queen, knave, seven, six, five, four, three, deuce*; in all 9. The reason why the ace of spades and ace of clubs are not mentioned, is, because they are always trumps, in whatever suit that is played. The ace of spades being always the first, and the ace of clubs the third trump; for the cards ranked according to their value when *trumps* stand in the following order.

Hearts and diamonds SPADILL, or the *ace of spades*; MANILL, the *seventh* of the two *red suits*; BASTO, the *ace of clubs*; PONTO, the *ace of hearts and diamonds*; *king, queen, knave, deuce, three, four, five, six*; in all 12. Spades and clubs, SPADILL the *ace of spades*, MANILL the *deuce of spades and clubs*, BASTO the *ace of clubs*; *king, queen, knave, seven, six, five, four, three*; in all 11. It is here to be observed, that the card which is *manill* and the second trump, is always the lowest in its suit when not trumps; and that the ace of hearts or diamonds, which when trump is above the king, is below the knave when not trump.

There are three matadores; spadill, manill, and basto; the privilege of which is, that when the player has no other trumps but them, and trumps are led, he is not obliged to play them, but may play what card he thinks proper, provided, however, that the trump led is of an inferior rank; but if spadill should be led, he that has manill or basto only, is obliged to play it; it is the same of manill basto, with respect to the superior matadore always forcing the inferior. Though there are properly but three matadores, nevertheless, all those trumps which follow the three first without interruption, are likewise called matadores; but the three first only enjoy the privilege above mentioned.

Each person is to play as he judges most convenient for his own game. He is not to encourage his friend to play; but each person ought to know what to do when it is his turn to play. The stakes consist of seven equal mils or *contrats*, as they are sometimes called, comprising the ten counters and fishes, which are given to each player. A mil is equal to ten fish, and each

fish to ten counters: the value of the fish is according to the players agreement, as also the number of tours, which are generally fixed at ten, and marked by turning the corners of a card.

If the cards should happen not to be dealt right, or that there should be two cards of the same sort, as two deuces of spades, for example, there must be a new deal; provided it is discovered before the cards are all played. The cards must likewise be dealt over again in case a card is turned in dealing, as it might be of prejudice to him who should have it; and of course if there should be several cards turned. There is no penalty for dealing wrong, he who does so must only deal again.

When each player has got his ten cards, he that is on the right hand of the dealer, after examining his game, and finding his hand fit to play, asks if they play; or if he has not a good hand, he passes, and so the second, third, and fourth. All the four may pass; but he that has spadill, after having shown or named it, is obliged to play by calling a king. Whether the deal is played in this manner, or that one of the players has asked leave, nobody choosing to play without calling, the eldest hand must begin the play, first naming his suit, and the king which he calls; he who wins the trick plays another card, and so of the rest till the game is finished. The tricks then are counted; and if the ombre, that is, he who stands the game, has, together with him who is the king called, six tricks, they have won and are paid the game, the consolation, and the matadores, if they have them, and divide what is upon the game, and the beasts if there are any. But if they make only five tricks, it is a remise, and they are beasted, what goes upon the game, paying to the other players the consolation and the matadores. If the tricks are equally divided betwixt them, they are likewise beasted; and if they make only four tricks between them, it is a remise; if they make less they lose codill (A), and in that case they pay to their adversaries what they should have received if they had won; that is, the game, the consolation, and the matadores, if they have them, and are beasted what is upon the game: they who win codill, divide the stakes. The beast, and every thing else that is paid, is paid equally betwixt the two losers; one half by him that calls, and the other half by him that is called, as well in case of codill as a remise; unless the ombre does not make three tricks, in which case he that is called is not only exempted from paying half the beast, but also the game, the consolation, and the matadores if there are any, which the ombre in that case pays alone; and as well in case of a codill as a remise. This is done in order to oblige players not to play games that are unreasonable. There is, nevertheless, one case in which if the ombre makes only one trick, he is not beasted alone, and that is, when not having a good hand he passes, and all the other players have passed likewise; he having spadill is obliged to play. Here it would be unjust to oblige him to make three or four tricks; in this case, therefore, he that is

4 Z 2

called

(A) Codill is when those who defend the pool make more tricks than they who stand the game; which is called *winning the codill*.

Quadrille

called pays one half of the losings. For which reason he that has spadill with a bad hand, should pass, that if he is afterwards obliged to play by calling a king (which is called *forced spadill*), he may not be beasted alone. He that has once passed cannot be admitted to play; and he that has asked leave cannot refuse to play, unless any one should offer to play without calling.

He that has four kings, may call a queen to one of his kings, except that which is trump. He that wants one or more kings, may call one of those kings; but in that case, he must make six tricks alone, and consequently he wins or loses alone. The king of that suit in which he plays cannot be called. No one should play out of his turn, although he is not beasted for so doing. If he who is not the eldest hand has the king called, and plays spadill, manill, or basto, or even the king called in order to show that he is the friend, having other kings that he fears the ombre should trump, he is not to be allowed to go for the vole; he is even beasted, if it appears to be done with that intent. It is not permitted to show a hand though codill may already be won; that it may be seen whether the ombre is beasted alone. If the ombre or his friend shows their cards before they have made six tricks, thinking that they have made them, and there appears a possibility of preventing their making them, the other players can oblige them to play their cards as they think proper.

A player need only name his suit when he plays, without calling a king. He who plays without calling must make six tricks alone to win; for all the other players are united against him, and they are to do what they can to prevent his winning. He who plays without calling, is admitted to play in preference to him who would play with calling; however, if he that has asked leave will play without calling, he has the preference of the other who would force him. These are the two methods of play without calling that are called forced.

As he who plays without calling does not divide the winnings with any person, he consequently, when he loses, pays all by himself; if he loses by remise he is beasted, and pays each of the other players the consolation, the *sans appeller* (which is commonly, but improperly, called the *sans prendre*), and the matadores if there are any; if he loses codill he is likewise beasted, and pays to each player what he would have received from each if he had win. They who win codill divide what there is; and if there are any counters remaining, they belong to him of the three who shall have spadill or the highest trump the next deal. It is the same with regard to him who calls one of his own kings, he wins alone or loses alone as in the other case, except the *sans appeller*, which he does not pay if he loses, or receive if he wins, although he plays alone.

If he plays *sans appeller*, though he may have a sure game, he is obliged to name his suit; which if he neglects to do, and shows his cards, and says "I play *sans appeller*;" in that case either of the other players can oblige him to play in what suit he pleases, although he should not have one trump in that suit.

He who has asked leave is not permitted to play *sans appeller*, unless he is forced; in which case, as was

said before, he has the preference of the other that *Quadrille* forces him.

A player is not obliged to trump when he has none of the suit led, nor play a higher card in that suit if he has it, being at his option although he is the last player, and the trick should belong to the ombre; but he is obliged to play in the suit led if he can, otherwise he renounces. If he separates a card from his game and shows it, he is obliged to play it, if by not doing it the game may be prejudiced, or if it can give any intelligence to his friend; but especially if it should be a matadore.—He that plays *sans appeller*, or by calling himself, is not subject to this law. He may turn the tricks made by the other players, and count what has been played as often as it is his turn to play, but not otherwise. If instead of turning a player's tricks, he turns and sees his game, or shows it to the other players, he is beasted, together with him whose cards he turned; and each of them must pay one half of the beast.

If any one renounces, he is beasted as often as he has renounced and it is detected; but a renounce is not made till the trick is turned. If the renounce is discovered before the deal is finished, and has been detrimental to the game, the cards must be taken up again, and the game replayed from that trick where the renounce was made; but if the cards are all played, the beast is still made, and the cards must not be replayed; except there should be several renounces in the same deal: then they are to be played again, unless the cards should be mixed. If several beasts are made in the same deal, they all go together, unless it is otherwise agreed at the beginning of the party; and when there are several beasts, the greatest always goes first.

A great advantage accrues from being eldest hand at quadrille, which often renders it very disagreeable to the rest of the players, being obliged to pass with a good hand unless they choose to play alone; and when it happens that the eldest hand having asked leave, the second player has three matadores, several trumps in back, and all small cards, he cannot then even play alone; and having no chance of being called, he must pass with this good hand. On account of which, this method has been thought expedient to remedy this defect of the game; each player having an opportunity of availing himself of the goodness of his game, by adding to the usual method of playing the game that of the mediateur, and the favourite suit.

The first thing to be observed is that of drawing for places, which is done in this manner: One of the players takes four cards; a king, a queen, a knave, and an ace; each player draws one of these cards; and commonly he who comes in last, draws first. The person who draws the king sits where he pleases, the queen at his right hand, the knave next the queen, and the ace on the left of the king. The king draws the favourite suit. The number of cards and persons is the same at this game as the other, and is played in the same manner.

The favourite suit is determined by drawing a card out of the pack, and is of the same suit, during the whole party, of the card so drawn.

A king is the mediateur, which is demanded of the others by one of the players, who has a hand he expects

Quadrille
II.
Quail.

Quail,
Quakers.

pects to make five tricks of; and through the assistance of this king he can play alone and make six tricks.

In return for the king received, he gives what card he thinks proper with a fish; but must give two fish if it is in the favourite suit. He who asks by calling in the favourite suit, has the preference to him who asks by calling in any other; he who asks with the mediateur, has the preference to him who asks by calling in the favourite suit, and by playing alone is obliged to make six tricks to win. He who asks with the mediateur in the favourite suit, has the preference to him who asks with the mediateur in any other suit, and is obliged to play alone, and to make six tricks.

If fans prendre is played in any other suit than the favourite, he who plays it has the preference to him who asks only, or with the mediateur, or even he who plays in the favourite suit with the mediateur; and the fans prendre in the favourite suit has the preference to all other players whatever.

The only difference between this method of playing the game and the other is, that when one of the players demands the mediateur he is obliged to play alone, and to make six tricks, as if he played fans prendre. In this case he should judge from the strength of his hand, whether the aid of the king will enable him to play alone or not.

With the mediateur and without the favourite suit it is played in this manner. The game is marked and played the same as in common, except that a fish extraordinary is given to him who plays the mediateur, and to him who plays fans prendre; that is, he who wins the mediateur receives 13 counters from each; and if he loses by remise he pays 12 to each; and 13 if by codill. The winner of fans prendre receives 17 counters from each; and if by remise he loses, he pays 16 to each, and 17 if by codill.

The vole with the mediateur receives one fish only, as at common quadrille. The beasts are also the same as the common game. The last game is generally played double, and is called *paulans*; but for those who choose to play a higher game, they may play the double colour, which is called the *Turk*, and is double of the favourite suit. There is also a higher game than this called the *auòle*, which is paying whatever is agreed to him who happens to hold the two aces in his hand.

We have omitted many things respecting the mode of marking the game, and playing the vole, because these are different in different cases, and are to be learned only by practice. The game itself is a very inferior one; but he who wishes to know more of it, may consult Hoyle's games improved by James Beaufort, Esq; from which we have, with very little alteration, taken this article.

QUADRUPEDS, in zoology; those animals which have four limbs or legs proceeding from the trunk of their body. See ZOOLOGY; in which article notice will be taken of the method of preserving specimens of these and other animals.

QUÆSTOR, see QUESTOR.

QUAGGA, or QUACHA. See EQUUS, n° 5.

QUAIL, in zoology. See TETRAO.

Quails are to be taken by means of the call during their whole wooing time, which lasts from April to August. The proper times for using the call are at sun-rising, at nine o'clock in the morning, at three in

the afternoon, and at sun-set; for these are the natural times of the quail's calling. The notes of the cock and hen quail are very different; and the sportsman who expects to succeed in the taking them must be expert in both: for when the cock calls, the answer is to be made in the hen's note; and when the hen calls, the answer is to be made in the cock's. By this means they will come up to the person, so that he may, with great ease, throw the net over them and take them. If a cock-quail be single, on hearing the hen's note he will immediately come; but if he have a hen already with him, he will not forsake her. Sometimes, though only one quail answers to the call, there will three or four come up; and then it is best to have patience, and not run to take up the first, but stay till they are all entangled, as they will soon be.

The quail is a neat cleanly bird, and will not run much into dirty or wet places: in dewy mornings, they will often fly instead of running to the call; and in this case, it is best to let them go over the net, if it so happens that they fly higher than its top; and the sportsman then changing sides, and calling again, the bird will come back, and then will probably be taken in the net.

The calls are to be made of a small leather purse, about two fingers wide, and four fingers long, and made in the shape of a pear; this is to be stuffed half-full of horse-hair, and at the end of it is to be placed a small whistle, made of the bone of a rabbit's leg, or some other such bone: this is to be about two inches long, and the end formed like a flageolet, with a little soft wax. This is to be the end fastened into the purse; the other is to be closed up with the same wax, only that a hole is to be opened with a pin, to make it give a distinct and clear sound. To make this sound, it is to be held full in the palm of the hand, with one of the fingers placed over the top of the wax; then the purse is to be pressed, and the finger is to shake over the middle of it, to modulate the sound it gives into a sort of shake. This is the most useful call; for it imitates the note of the hen-quail, and seldom fails to bring a cock to the net if there be one near the place.

The call that imitates the note of the cock, and is used to bring the hen to him, is to be about four inches long, and above an inch thick; it is to be made of a piece of wire turned round and curled, and covered with leather; and one end of it must be closed up with a piece of flat wood, about the middle of which there must be a small thread or strap of leather, and at the other end is to be placed the same sort of pipe, made of bone, as is used in the other call. The noise is made by opening and closing the spiral, and gives the same sound that the cock does when he gives the hen a signal that he is near her.

QUAKERS, a religious society, which took its rise in England about the middle of the last century, and rapidly found its way into other countries in Europe, and into the English settlements in North America.—The members of this society, we believe, called themselves at first *seekers*, from their *seeking* the truth; but after the society was formed, they assumed the appellation of *friends*. The name of *quakers* was given to them by their enemies; and though an epithet of reproach, seems to be stamped upon them indelibly. Their founder

Quakers

See Month.
Rev. Sept.
1793, art. 5.

der is generally believed to have been George Fox, an illiterate shoemaker (see *George Fox*), but this opinion has been lately controverted. An ingenious writer ‡ having found, or fancied, a similarity of sentiments among the ancient Druids and modern Quakers, seems to think that Fox must have been nothing more than a tool employed by certain deists to pave the way for their system of natural religion, by allegorizing the distinguishing articles of the Christian faith.

It must be confessed, for experience will not allow it to be denied, that extremes in religion are very apt to beget each other; and if the deists alluded to reasoned from this fact, they could not have pitched upon a tool fitter for their purpose than George Fox. From his works still extant, he appears to have been one of the most extravagant and absurd enthusiasts that ever lived, and to have fancied himself, in his apostolic character, something infinitely superior to man. In a book called *News coming out of the North* (p. 15.) he says of himself, "I am the Door that ever was, the same Christ yesterday, to-day, and for ever." And in the introduction to his *Battle-door for Teachers and Professors*, he says, "All languages are to me no more than dust, who was before languages were." But one of the most extraordinary and blasphemous things that he ever wrote, is an answer to the Protector, who had required him to promise not to disturb his government as then established. It is as follows:

"I who am of the world called G: F doth deny the carrying or drawing any carnal sword against any, or against thee O: C: or any man, in the presence of the Lord I declare it, God is my witness, by whom I am moved to give this forth for the truth's sake, from him whom the world calls G: Fox, *who is the son of God*, who is sent to stand a witness against all violence and against the works of darkness, and to turn the people from darkness to light, and to bring them from the occasion of the war and from the occasion of the magistrates sword, which is a terror to the evil doer, which acts contrary to the light of the Lord *Jesus Christ*; which is a praise to them that do well; which is a protection to them that do well, and not the evil; and such soldiers as are put in place no false accusers must be, no violence must do, but be content with their wages: and that magistrate bears not the sword in vain, from under the occasion of that sword do I seek to bring people: my weapons are not carnal but spiritual, and *my kingdom is not of this world*; therefore with carnal weapon I do not fight, but am from those things dead, from him who is not of this world, called of the world by the name of G: F: and this I am ready to seal with my blood; this I am moved to give forth for the truth's sake, who a witness stands against all unrighteousness, and all ungodliness, who a sufferer is for the righteous seed's sake, waiting for the redemption of it, who a crown that is mortal seeks not, for that fadeth away;

but in the light dwells which comprehends that crown, which light is the condemnation of all such, in which light I witness the crown that is immortal, which fades not away from him who to all your souls is a friend, for establishing of righteousness, and clearing the land of evil doers, and a witness against all the wicked inventions of man, and murderer's plots, which answer shall be with the light in all your consciences, which makes no covenant with death; to which light in you all I speak, and am clear, G: F: who a new name hath, which the world knows not." (A).

The Quakers, however, did not long entrust the defence of their principles to such senseless enthusiasts as George Fox: They were joined by a number of learned, ingenious, and pious men, who new-modelled their creed; and though they did not bring it to what is generally deemed the Christian standard, they so reformed it as that its tenets do not shock common sense, nor the duties prescribed scandalize a man of piety. The chief of these reformers were George Keith, the celebrated Penn, and our countryman Barclay. Keith was indeed excommunicated for the liberties which he took with the great apostle; but we have not a doubt but his writings contributed to the moderation of Penn, and to the elegant and masterly apology of Barclay. From that apology we selected the summary of their opinions which was given in the former edition of this work; but they have lately published such a summary themselves, of which the reader will be pleased with the following abstract:

They tell us, that about the beginning of the 17th century, a number of men, dissatisfied with all the modes of religious worship then known in the world, withdrew from the communion of every visible church to seek the Lord in retirement. Among these was their *honourable elder George Fox*, who being quickened by the immediate touches of divine love, could not satisfy his apprehensions of duty to God without directing the people where to find the like consolation and instruction. In the course of his travels, he met with many seeking persons in circumstances similar to his own, and these readily received his testimony. They then give us a short account of their sufferings and different settlements; and with a degree of candour which does them infinite credit, they vindicate Charles II. from the character of a persecutor; acknowledging, that though they suffered much during his reign, he gave as little countenance as he could to the severities of the legislature. They even tell us, that he exerted his influence to rescue their friends from the unprovoked and cruel persecutions of the New England fanatics; and they speak with becoming gratitude of the different acts passed in their favour during the reigns of William and Mary, and George I. They then proceed to give us the following account of their doctrine:

"We

(A) We have transcribed this letter from the theological works of Mr Leslie, where it is preserved in its original form. The Quakers, after the death of their apostle, expunged from their edition of it the words which we have printed in Italics; ashamed, as we hope, of the blasphemy imputed to them: but that Mr Leslie's copy is authentic, is thus attested by two of the friends, who saw Fox deliver it to the protector's messenger: "We are witnesses of this testimony, whose names in the flesh are,

Tho. Aldam.
Rob. Craven

Quakers.

"We agree with other professors of the Christian name, in the belief in one eternal God, the Creator and Preserver of the universe; and in Jesus Christ his Son, the Messiah, and Mediator of the new covenant (Heb. xii. 24).

"When we speak of the gracious display of the love of God to mankind, in the miraculous conception, birth, life, miracles, death, resurrection, and ascension of our Saviour, we prefer the use of such terms as we find in Scripture; and, contented with that knowledge which divine wisdom hath seen meet to reveal, we attempt not to explain those mysteries which remain under the veil; nevertheless, we acknowledge and assert the divinity of Christ, who is the wisdom and power of God unto salvation (1 Cor. i. 24).

"To Christ alone we give the title of the Word of God (John i. 1.) and not to the Scriptures; although we highly esteem these sacred writings, in subordination to the Spirit (2 Pet. i. 21.), from which they were given forth; and we hold, with the apostle Paul, that they are able to make wise unto salvation, through faith which is in Christ Jesus (2 Tim. iii. 15).

"We reverence those most excellent precepts which are recorded in Scripture to have been delivered by our great Lord, and we firmly believe that they are practicable, and binding on every Christian; and that in the life to come every man will be rewarded according to his works (Mat. xvi. 27). And farther, it is our belief, that, in order to enable mankind to put in practice these sacred precepts, many of which are contradictory to the unregenerate will of man (John i. 9.), every man coming into the world is endued with a measure of the light, grace, or good Spirit of Christ; by which, as it is attended to, he is enabled to distinguish good from evil, and to correct the disorderly passions and corrupt propensities of his nature, which mere reason is altogether insufficient to overcome. For all that belongs to man is fallible, within the reach of temptation; but this divine grace, which comes by Him who hath overcome the world (John xvi. 33.) is, to those who humbly and sincerely seek it, an all-sufficient and present help in time of need. By this the snares of the enemy are detected, his allurements avoided, and deliverance is experienced through faith in its effectual operation; whereby the soul is translated out of the kingdom of darkness, and from under the power of Satan, into the marvellous light and kingdom of the Son of God.

"Being thus persuaded that man, without the Spirit of Christ inwardly revealed, can do nothing to the glory of God, or to effect his own salvation; we think this influence especially necessary to the performance of the highest act of which the human mind is capable, even the worship of the Father of lights and of spirits, in spirit and in truth; therefore we consider as obstructions to pure worship, all forms which divert the attention of the mind from the secret influence of this unction from the Holy One (1 John ii. 20, 27). Yet, although true worship is not confined to time and place, we think it incumbent on Christians to meet often together (Heb. x. 25.) in testimony of their dependence on the heavenly Father, and for a renewal of their spiritual strength: nevertheless, in the performance of worship, we dare not depend, for our acceptance with Him, on a formal repetition of the words and experiences of others; but we believe it to be our duty to cease from

Quakers.

the activity of the imagination, and to wait in silence to have a true sight of our condition bestowed upon us: believing even a single sigh (Rom. viii. 26.) arising from such a sense of our infirmities, and of the need we have of divine help, to be more acceptable to God, than any performances, however specious, which originate in the will of man.

"From what has been said respecting worship, it follows, that the ministry we approve must have its origin from the same source: for that which is needful for a man's own direction, and for his acceptance with God (Jer. xxiii. 30, to 32.) must be eminently so to enable him to be helpful to others. Accordingly, we believe the renewed assistance of the light and power of Christ to be indispensably necessary for all true ministry; and that this holy influence is not at our command, or to be procured by study, but is the free gift of God to his chosen and devoted servants.—From hence arises our testimony against preaching for hire, and in contradiction to Christ's positive command, "Freely ye have received, freely give;" (Mat. x. 8.) and hence our conscientious refusal to support such ministry by tithes or other means.

"As we dare not encourage any ministry but that which we believe to spring from the influence of the Holy Spirit, so neither dare we attempt to restrain this influence to persons of any condition in life, or to the male sex alone; but, as male and female are one in Christ, we allow such of the female sex as we believe to be endued with a right qualification for the ministry, to exercise their gifts for the general edification of the church: and this liberty we esteem to be a peculiar mark of the gospel dispensation, as foretold by the prophet Joel (Joel ii. 28, 29.) and noticed by the apostle Peter (Acts ii. 16, 17).

"There are two ceremonies in use amongst most professors of the Christian name; Water-baptism, and what is termed the Lord's Supper. The first of these is generally esteemed the essential means of initiation into the church of Christ; and the latter of maintaining communion with him. But as we have been convinced, that nothing short of his redeeming power, inwardly revealed, can set the soul free from the thralldom of sin, by this power alone we believe salvation to be effected. We hold that as there is one Lord and one faith (Eph. iv. 5.), so his baptism is one in nature and operation; that nothing short of it can make us living members of his mystical body; and that the baptism with water, administered by his fore-runner John, belonged, as the latter confessed, to an inferior and decreasing dispensation (John iii. 30).

"With respect to the other rite, we believe that communion between Christ and his church is not maintained by that nor any other external performance, but only by a real participation of his divine nature (2 Pet. i. 4.) through faith; that this is the supper alluded to in the Revelation (Rev. iii. 20.), "Behold I stand at the door and knock, if any man hear my voice, and open the door, I will come in to him, and will sup with him, and he with me;" and that where the substance is attained, it is unnecessary to attend to the shadow, which doth not confer grace, and concerning which opinions so different, and animosities so violent, have arisen.

"Now, as we thus believe that the grace of God, which comes by Jesus Christ, is alone sufficient for sal-

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Quakers.

vation, we can neither admit that it is conferred on a few only, whilst others are left without it ; nor, thus asserting its universality, can we limit its operation to a partial cleansing of the soul from sin, even in this life. We entertain worthier notions both of the power and goodness of our heavenly Father, and believe that he doth vouchsafe to assist the obedient to experience a total surrender of the natural will to the guidance of his pure unerring Spirit ; through whose renewed assistance they are enabled to bring forth fruits unto holiness, and to stand perfect in their present rank (Mat. v. 48. ; Eph. iv. 13. ; Col. iv. 12.)

* See Outl.

" There are not many of our tenets more generally known than our testimony against oaths and against war. With respect to the former of these, we abide literally by Christ's positive injunction, delivered in his sermon on the mount, "Swear not at all" (Mat. v. 34)*. From the same sacred collection of the most excellent precepts of moral and religious duty, from the example of our Lord himself (Mat. ch. v. 39, 44, &c. ch. xxvi. 52, 53. ; Luke xxii. 51. ; John xviii. 11.), and from the correspondent convictions of his Spirit in our hearts, we are confirmed in the belief that wars and fightings are, in their origin and effects, utterly repugnant to the Gospel, which still breathes peace and good-will to men. We also are clearly of the judgment, that if the benevolence of the Gospel were generally prevalent in the minds of men, it would effectually prevent them from oppressing, much more from enslaving, their brethren, (of whatever colour or complexion), for whom, as for themselves, Christ died ; and would even influence their conduct in their treatment of the brute creation, which would no longer groan the victims of their avarice, and of their false ideas of pleasure.

" Some of our tenets have in former times, as hath been shown, subjected our friends to much suffering from government, though to the salutary purposes of government our principles are a security. They inculcate submission to the laws in all cases wherein conscience is not violated. But we hold, that as Christ's kingdom is not of this world, it is not the business of the civil magistrate to interfere in matters of religion ; but to maintain the external peace and good order of the community. We therefore think persecution, even in the smallest degree, unwarrantable. We are careful in requiring our members not to be concerned in illicit trade, nor in any manner to defraud the revenue.

" It is well known that the society, from its first appearance, has disused those names of the months and days which, having been given in honour of the heroes or false gods of the heathens, originated in their flattery or superstition ; and the custom of speaking to a single person in the plural number (B), as having arisen also from motives of adulation. Compliments, superfluity of apparel and furniture, outward shows of rejoicing and mourning, and observation of days and times, we esteem to be incompatible with the simplicity and sincerity of a Christian life ; and public diversions, gaming, and other vain amusements of the world, we cannot but condemn. They are a waste of that time

which is given us for nobler purposes, and divert the attention of the mind from the sorer duties of life, and from the reproofs of instruction, by which we are guided to an everlasting inheritance.

" To conclude, although we have exhibited the several tenets which distinguish our religious society, as objects of our belief, yet we are sensible that a true and living faith is not produced in the mind of man by his own effort ; but is the free gift of God (Eph. ii. 8.) in Christ Jesus, nourished and increased by the progressive operation of his spirit in our hearts, and our proportionate obedience (John vii. 17.). Therefore, although, for the preservation of the testimonies given us to bear, and for the peace and good order of the society, we deem it necessary that those who are admitted into membership with us, should be previously convinced of those doctrines which we esteem essential ; yet we require no formal subscription to any articles, either as the condition of membership, or to qualify for the service of the church. We prefer the judging of men by their fruits, in a dependence on the aid of Him who, by his prophet, hath promised to be " a spirit of judgment to him that sitteth in judgment" (Isaiah xxviii. 6). Without this, there is a danger of receiving numbers into outward communion, without any addition to that spiritual sheepfold, whereof our blessed Lord declared himself to be both the door and the shepherd (John x. 7, 11.) that is, such as know his voice, and follow him in the paths of obedience."

Such are the doctrines of this people as we find them stated in a small pamphlet lately presented by themselves to the public ; and in the same tract they give the following account of their discipline.

" In the practice of discipline, we think it indispensable that the order recommended by Christ himself be invariably observed : (Matth. xviii. 15. to 17.) ' If thy brother shall trespass against thee, go and tell him his fault between thee and him alone : if he shall hear thee, thou hast gained thy brother ; but if he will not hear thee, then take with thee one or two more, that in the mouth of two or three witnesses every word may be established ; and if he shall neglect to hear them, tell it unto the church.'

" To effect the salutary purposes of discipline, meetings were appointed, at an early period of the society, which, from the times of their being held, were called quarterly-meetings. It was afterwards found expedient to divide the districts of those meetings, and to meet more often ; whence arose monthly-meetings, subordinate to those held quarterly. At length, in 1669, a yearly-meeting was established, to superintend, assist, and provide, rules for the whole ; previous to which, general meetings had been occasionally held.

" A monthly-meeting is usually composed of several particular congregations, situated within a convenient distance of each other. Its business is to provide for the subsistence of their poor, and for the education of their offspring ; to judge of the sincerity and fitness of persons appearing to be convinced of the religious principles of the society, and desiring to be admitted

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(B) Speaking of this custom, Fox says : " When the Lord sent me into the world, he forbade me to put off my hat to any ; and I was required to *thee* and *thou* all men and women." *Journal*, p. 24.

Quaker.

Quaker.

into membership; to excite due attention to the discharge of religious and moral duty; and to deal with disorderly members. Monthly-meetings also grant to such of their members as remove into other monthly-meetings, certificates of their membership and conduct; without which they cannot gain membership in such meetings. Each monthly-meeting is required to appoint certain persons under the name of *overseers*, who are to take care that the rules of our discipline be put in practice; and when any case of complaint or disorderly conduct comes to their knowledge, to see that private admonition, agreeable to the gospel rule before-mentioned, be given previously to its being laid before the monthly-meeting.

"When a case is introduced, it is usual for a small committee to be appointed to visit the offender, to endeavour to convince him of his error, and to induce him to forsake and condemn it. If they succeed, the person is by minute declared to have made satisfaction for the offence; if not, he is disowned as a member of the society.

"In disputes between individuals, it has long been the decided judgment of the society that its members should not sue each other at law. It therefore enjoins all to end their differences by speedy and impartial arbitration, agreeable to rules laid down. If any refuse to adopt this mode, or, having adopted it, to submit to the award, it is the direction of the yearly-meeting that such be disowned.

"To monthly-meetings also belongs the allowing of marriages; for our society hath always scrupled to acknowledge the exclusive authority of the priests in the solemnization of marriage. Those who intend to marry, appear together and propose their intention to the monthly-meeting; and if not attended by their parents or guardians, produce a written certificate of their consent, signed in the presence of witnesses. The meeting then appoints a committee to inquire whether they are clear of other engagements respecting marriage; and if at a subsequent meeting, to which the parties also come and declare the continuance of their intention, no objections are reported, they have the meeting's consent to solemnize their intended marriage. This is done in a public meeting for worship; towards the close whereof the parties stand up, and solemnly take each other for husband and wife. A certificate of the proceedings is then publicly read, and signed by the parties, and afterwards by the relations and others as witnesses. Of such certificates the monthly-meeting keeps a record; as also of the births and burials of its members. A certificate of the date, of the name of the infant, and of its parents, signed by those present at the birth, is the subject of one of these last-mentioned records; and an order for the interment, counter-signed by the grave-maker, of the other. The naming of children is without ceremony. Burials are

Vol. XV. Part II.

also conducted in a simple manner. The body, followed by the relations and friends, is sometimes, previously to interment, carried to a meeting; and at the grave a pause is generally made; on both which occasions it frequently falls out that one or more friends present have somewhat to express for the edification of those who attend; but no religious rite is considered as an essential part of burial.

"Several monthly-meetings compose a quarterly-meeting. At the quarterly-meeting are produced written answers from the monthly-meetings, to certain queries respecting the conduct of their members, and the meeting's care over them. The accounts thus received are digested into one, which is sent, also in the form of answers to queries, by representatives, to the yearly-meeting.—Appeals from the judgment of monthly-meetings are brought to the quarterly-meetings; whose business also it is to assist in any difficult case, or where remissness appears in the care of the monthly-meetings over the individuals who compose them.

"The yearly-meeting has the general superintendence of the society in the country in which it is established (c); and therefore, as the accounts which it receives discover the state of inferior meetings, as particular exigencies require, or as the meeting is impressed with a sense of duty, it gives forth its advice, makes such regulations as appear to be requisite, or excites to the observance of those already made; and sometimes appoints committees to visit those quarterly-meetings which appear to be in need of immediate help. Appeals from the judgment of quarterly-meetings are here finally determined; and a brotherly correspondence, by epistles, is maintained with other yearly-meetings.

"In this place it is proper to add, that as we believe women may be rightly called to the work of the ministry, we also think, that to them belongs a share in the support of our Christian discipline; and that some parts of it, wherein their own sex is concerned, devolve on them with peculiar propriety. Accordingly they have monthly, quarterly, and yearly-meetings of their own sex, held at the same time and in the same place with those of the men; but separately, and without the power of making rules: and it may be remarked, that during the persecutions, which in the last century occasioned the imprisonment of so many of the men, the care of the poor often fell on the women, and was by them satisfactorily administered.

"In order that those who are in the situation of ministers may have the tender sympathy and counsel of those of either sex, who, by their experience in the work of religion, are qualified for that service; the monthly-meetings are advised to select such, under the denomination of *elders*. These, and ministers approved by their monthly-meetings (d), have meetings peculiar to themselves, called meetings of ministers and elders;

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(c) "There are seven yearly meetings, viz. 1st, London, to which come representatives from Ireland; 2d, New-England; 3d, New-York; 4th, Pennsylvania and New-Jersey; 5th, Maryland; 6th, Virginia; 7th, the Carolinas and Georgia."

(d) "Those who believe themselves required to speak in meetings for worship, are not immediately acknowledged as ministers by their monthly-meetings; but time is taken for judgment, that the meeting may be satisfied of their call and qualification. It will also sometimes happen, that such as are not approved, will obtrude themselves as ministers, to the grief of their brethren; but much forbearance is used towards these, before the disapprobation of the meeting is publicly testified."

Quaker.

in which they have an opportunity of exciting each other to a discharge of their several duties, and of extending advice to those who may appear weak, without any needless exposure. These meetings are generally held in the compass of each monthly, quarterly, and yearly-meeting. They are conducted by rules prescribed by the yearly-meeting, and have no authority to make any alteration or addition to them. The members of them unite with their brethren in the meetings for discipline, and are equally accountable to the latter for their conduct.

"It is to a meeting of this kind held in London, called the second-day morning-meeting, that the revival of manuscripts concerning our principles, previously to publication, is intrusted by the yearly-meeting held in London; and also the granting, in the intervals of the yearly-meeting, certificates of approbation to such ministers as are concerned to travel in the work of the ministry in foreign parts. When a visit of this kind doth not extend beyond Great Britain, a certificate from the monthly-meeting of which the minister is a member is sufficient; if to Ireland, the concurrence of the quarterly-meeting is also required. Regulations of similar tendency obtain in other yearly-meetings.

"The yearly-meeting held in London, in the year 1675, appointed a meeting to be held in that city, for the purpose of advising and assisting in cases of suffering for conscience sake, which hath continued with great use to the society to this day. It is composed of friends under the name of correspondents, chosen by the several quarterly-meetings, and who reside in or near the city. The same meetings also appoint members of their own in the country as correspondents, who are to join their brethren in London on emergency. The names of all these correspondents, previous to their being recorded as such, are submitted to the approbation of the yearly-meeting. Those of the men who are approved ministers are also members of this meeting, which is called the *meeting for sufferings*; a name arising from its original purpose, which is not yet become entirely obsolete.

"The yearly-meeting has intrusted the meeting for sufferings with the care of printing and distributing books, and with the management of its stock; and considered as a standing committee of the yearly-meeting, it hath a general care of whatever may arise, during the intervals of that meeting, affecting the society, and requiring immediate attention: particularly of those circumstances which may occasion an application to government.

"There is not in any of the meetings which have been mentioned any president, as we believe that Divine Wisdom alone ought to preside; nor hath any member a right to claim pre-eminence over the rest. The office of clerk, with a few exceptions, is undertaken voluntarily by some member; as is also the keeping of the records. Where these are very voluminous, and require a house for their deposit (as is the case in London, where the general records of the society in Great Britain are kept), a clerk is hired to have the care of them; but except a few clerks of this kind, and persons who have the care of meeting-houses, none receive any stipend or gratuity for their services in our religious society."

It is remarkable, that all the settlements of the Europeans in America, except the Quaker settlement of Pennsylvania, were made by force of arms, with very little regard to any prior title in the natives. The kings of Spain, Portugal, France, and Britain, together with the States of Holland, then the only maritime powers, gave grants of such parts of America as their people could lay hold on, studying only to avoid interference with their European neighbours. But Mr Penn, being a Quaker, did not think his power from King Cha. II. a sufficient title to the country since called *Pennsylvania*. He therefore assembled the sachems or princes then in that country, and purchased from them the extent of land that he wanted. The government of this province is mostly in the hands of the Quakers, who never have any quarrels with the natives. When they desire to extend their settlements, they purchase new lands of the sachems, never taking any thing from them by force. How unlike is this conduct to that of the Spaniards, who murdered millions of the natives of Mexico, Terra Firma, Peru, Chili, &c.

QUALITY is a word which, as used in philosophical disquisitions, cannot be explained by any periphrasis. That which is expressed by it must be brought into the immediate view of the senses or intellect, and the name properly applied, or he who is a stranger to the word will never be made to comprehend its meaning. Aristotle, who treated it as a general conception second in order among the ten *predicaments* or *categories* (see *CATEGORY*), gives several characters of it; but though they are all in some respects just, no man could from them, without other assistance, learn what *quality* is. Thus he tells us *, *ἡ ἀρετή ἐστὶν ἐν αὐτῷ κατὰ τὸ πρῶτον; ἡ δὲ ἐπιστήμη δὲ τοῦ ἄλλου καὶ τοῦ ἕτερου τὰ ποικίλα.* And again, *ὁμοία δὲ ἡ ἀνομοία κατὰ μόνους τὰς ποικίλας λέγεται ὁμοίον γὰρ εἶναι εἶναι οὐκ ἐστὶ καὶ ἄλλο οὐδὲν, ἢ καὶ ὁ πρῶτον γένος.*

* *Præf. ed. syib. p. 44.*
45.

When a man comprehends, by means of his senses and intellect, what it is which the word *quality* denotes, he will indeed perceive that the first of these characters is applicable to some qualities and not to others; that the second is more applicable to *quantity* than to *quality*; and that it is only the third which can with propriety be considered as the general characteristic of this predicament. Thus when we have learned by our sense of sight that *whiteness* is a quality of snow, and *blackness* of coal; and by means of observation and reflection, that *wisdom* is a quality of one man and *folly* of another—we must admit that the sensible quality of the snow is *contrary* to that of the coal, and the intellectual quality of wisdom contrary to that of folly. There is, however, no contrariety between *wisdom* and *whiteness* or *blackness*, nor between *hardness* or *softness*, and any *particular colour*; for sensible and intellectual qualities can never be compared; and it is not easy, if possible, to make a comparison between qualities perceptible only by different senses: Nay, among qualities perceptible by the same sense, we often meet with a difference where there is no contrariety; for though the *figure* of a *cube* is *different* from that of a *sphere*, and the *figure* of a *square* from that of a *circle*, the *sphere* is not *contrary* to the *cube*, nor the *circle* to the *square*.

His second characteristic of this genus is still less proper than the first. It is indeed true that some qualities admit of *intension* and *remission*; for snow is whiter than paper, and one woman is handsomer than another; but

Quality.

of the species of quality called *figure* we cannot predicate either *more* or *less*. A crown-piece may have as much of the *circular quality* in it as the plane of the equator, and a musket-bullet as much of the *spherical quality* as the orb of the sun. It is indeed a property of all *quantity* to admit of *intension* and *remission*; and therefore this ought to have been given as the character not of the second but of the third category. See QUANTITY.

2
Nothing known but qualities.

That it is only from a *comparison of their qualities* that things are denominated like or unlike, or that one thing cannot resemble another, but in some quality, is indeed a just observation. We know nothing directly but qualities sensible and intellectual (see METAPHYSICS, n° 149, 150, 151, and 227); and as these have no resemblance to each other, we conclude that body or matter, the subject of the former, is a being unlike mind, the subject of the latter. Even of bodies themselves we can say, that one is like or unlike another only by virtue of their qualities. A ball of ivory resembles a ball of snow in its *figure* and *colour*, but not in its *coldness* or *hardness*; a ball of lead may resemble a ball of snow in its *figure* and *coldness*, but not in its *colour*; and a cube of ivory resembles not a ball of lead either in *figure*, *colour*, or *coldness*. The mind of a brute resembles that of a man in its powers of *sensation* and *perception*, but does not resemble it in the powers of *volition* and *reasoning*; or at least, the resemblance, in this latter instance, is very slight. All bodies resemble one another in being solid and extended, and all minds in being more or less active. *Likeness* or *unlikeness* therefore is the universal characteristic of the category *quality*.

3
Important distinctions of quality.

Aristotle has other speculations respecting quality, which are worthy of notice. He distinguishes between qualities which are *essential* and those which are *accidental*; between qualities which are *natural* and those which are *acquired*; and he speaks of the qualities of *capacity* and those of *completion*. *Extension* and *figure* in general are qualities essential to all bodies; but a particular extension, such as an *inch* or an *ell*, and a particular figure, such as a *cube* or a *sphere*, are qualities accidental to bodies. Among the *natural* qualities of glass it is one to transmit objects of vision; but to enlarge these objects is an *adventitious* or *acquired* quality. The same quality may be *natural* in one substance, as attraction in the magnet; and *acquired* in another, as the same attraction in the magnetic bar. *Docility* may be called a quality *natural* to the mind of man, science an *acquired* one. To understand what he means by qualities of *capacity* and *completion*, it may be sufficient to observe that every piece of iron has the qualities of a razor in *capacity*, because it may be converted into steel, and formed into a razor; when it is so formed, it has, in the language of this sage, the quality of a razor in *completion*. Among the qualities of *capacity* and *completion*, the most important, and what may lead to interesting speculations, is the reasoning faculty of man. A *capacity* of reasoning is essential to the human mind; but the *completion* of this capacity or *actual reasoning* is not, otherwise *infants* and persons *asleep* would be excluded from the human species.

4
Overlooked by Locke. Mr Locke has puzzled his readers, and perhaps himself, with a question respecting the species of an idiot or changeling, whom he pronounces to be something between a man and a brute*. It is not often that we

Quality.

feel ourselves inclined to regret Locke's ignorance of Aristotle's distinctions; but we cannot help thinking, that had the British philosopher attended to the Stagyrice's account of qualities in *capacity* and qualities in *completion*, this perplexing question would never have been started. It is justly observed in the *Essay on Human Understanding*, that of *real essences* we know nothing: but that every man selects a certain number of qualities which he has always perceived united in certain beings; and forming these into one complex conception, gives to this conception a *specific* name, which he applies to every being in which he finds those qualities united. This is undoubtedly the process of the mind in forming genera and species; and as the excellent author refuses the name of *man* to the changeling, it is obvious that the complex conception, to which he gives that name, must imply *rationality* or the *actual exercise* of reason. But this limitation will exclude many beings from the species *man*, whom Mr Locke certainly considered as men and women. Not to mention infants and persons in sound sleep, how shall we class those who, after having lived 30 or 40 years in the full exercise of reason, have been suddenly or by degrees deprived of it by some disorder in the brain?

From Marlborough's eyes the streams of dotage flow;
And Swift expires a driveller and a show.

JOHNSON.

But were the hero and the wit in those deplorable circumstances excluded from the human species, and classed between men and brutes? No surely; they were both acknowledged to be men, because they were known to have the quality of reason in what Aristotle would have called *capacity*. Their dotage and drivelling originated from some disorder in their bodies, probably in the region of the brain; and Locke himself contends that no defect in body is sufficient to degrade a person from the rank of manhood. Again, lunatics have the exercise of reason, except at new and full moon. Are these unhappy beings sometimes men and sometimes a species by themselves between men and brutes?

It appears, therefore, that not the *actual exercise* of reason, but reason in *capacity*, ought to be included in the complex conception to which we give the specific name of *man*, as some of the greatest men that ever lived have been during parts of their lives deprived of the power of *actual reasoning*. This, however, it will be said, does not remove the difficulty; for the occasional exercise of reason in lunatics, and the great exertions of it in such men as Swift and Marlborough, show that they had it in *capacity* at all times; whereas we have no evidence that changelings have even a *capacity* of reasoning at any time, since they never do a rational action, nor ever utter a sentence to the purpose. That we have no *direct* and *positive* evidence of the minds of changelings being capable of reasoning, were they supplied with proper organs, must be granted; but the probabilities of their being so are many and great. We know by experience that the *actual exercise* of reason may be interrupted by an occasional and accidental pressure on the brain; and therefore we cannot doubt but that if this pressure were rendered permanent by any wrong configuration of the skull given to it in the womb, or in the act of being born into the world, an infant, with a mind capable of reasoning by means of proper organs,

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would by this accident be rendered, through the whole of life, an idiot or changeling. That idiotism is caused by such accidents, and is not the quality of an inferior mind occasionally given to a human body, will at least seem probable from the following considerations.

It does not appear that an animal body can live and move but while it is actuated by some mind. Whence then does the unborn infant derive its mind? It must be either immediately from God, or *ex traduce* from its parents; but if the mind of man be immaterial, it cannot be *ex traduce*. Now, as idiots are very few in number when compared with the rational part of the human species, and as God in the government of this world acts not by partial but by general laws; we must conclude that the law which he has established respecting the union of mind and matter, is, that human bodies shall be animated with minds endowed with a capacity of reasoning, and that those who never exert this capacity are prevented by some such accident as we have assigned.

For a further account of qualities, why they are supposed to inhere in some subject, together with the usual distinction between the primary and secondary qualities of matter, see METAPHYSICS, Part II. Chap. i.

CHEMICAL QUALITIES, those qualities principally introduced by means of chemical experiments, as fumigation, amalgamation, cupellation, volatilization, precipitation, &c.

QUALITY, is also used for a kind of title given to certain persons, in regard of their territories, signories, or other pretensions.

QUANGA, See CAPRA.

QUANG-PING-FOU, a city in China, is situated in the northern part of the province of Pe-tcheli, between the provinces of Chang-tong and Ho-nan, and has nine cities of the third class dependent on it; all its plains are well watered by rivers. Among its temples, there is one dedicated to those men who, as the Chinese pretend, discovered the secret of rendering themselves immortal.

QUANGSI, a province of China, bounded on the north by Koe-Tcheau and Hu-Quang; on the east, by Yunan and Quantong; on the south, by the same and Tonquin; and on the west, by Yun-nan. It produces great plenty of rice, being watered by several large rivers. The southern part is a flat country, and well cultivated; but the northern is full of mountains covered with trees. It contains mines of all sorts; and there is a gold-mine lately opened. The capital town is Quie-ling.

A very singular tree, says Grofier, grows in this province; instead of pith, it contains a soft pulp, which yields a kind of flour: the bread made of it is said to be exceedingly good. Besides paroquets, hedgehogs, porcupines, and rhinoceroses, a prodigious number of wild animals, curious birds, and uncommon insects, are found here.

This province contains 12 villages of the first class, and 80 of the second and third.

QUANG-RONG, a province of China, bounded on the east by Kiang-fi and Fokien; on the south, by the ocean; and on the west, by Tonquin. This province is diversified by valleys and mountains; and yields two crops of corn in a year. It abounds in gold, jewels, silk, pearls, tin, quicksilver, sugar, brass, iron, steel, salt-

petre, ebony, and several sorts of odoriferous wood; besides fruits of all sorts proper to the climate. They have a prodigious number of ducks, whose eggs they hatch in ovens; and a tree, whose wood is remarkably hard and heavy, and thence called *iron-wood*. The mountains are covered with a sort of oaks which creep along the ground, and of which they make baskets, hurdles, matts, and ropes.

Although the climate of this province is warm, the air is pure, and the people are robust and healthy. They are very industrious; and it must be allowed that they possess in an eminent degree the talent of imitation: if they are only shown any of our European works, they execute others like them with the most surprising exactness. This province suffered much during the civil wars; but at present it is one of the most flourishing in the empire; and, as it is at a great distance from court, its government is one of the most important. This province is divided into ten districts, which contain 10 cities of the first class, and 84 of the second and third. Canton is the capital town.

QUANTITY, as explained by the great English ¹Quantity lexicographer, is that property of any thing which may be increased or diminished. This interpretation of the word is certainly just, and for the purposes of common conversation it is sufficiently determinate; but the man of science may expect to find in a work like ours a definition of the thing signified. This, however, cannot be given him. A logical definition consists of the *genus* under which the thing defined is ranked, and the *specific difference* (see LOGIC, n° 20, &c.); but quantity is ranked under no genus. In that school where such definitions were most valued, it was considered as one of the ten *categories*, or general conceptions, under which all the objects of human apprehension were mustered, like soldiers in an army (see CATEGORY and PHILOSOPHY, n° 22.) On this account, even Aristotle himself, who delighted in definitions, and was not easily deterred from a favourite pursuit, could not consistently with his own rules attempt to define *quantity*. He ²Characterizes it, however, in several parts of his works; ^{ized by} *Aristotle* and particularly in the 15th chapter of the 4th book of his metaphysics, where he gives the following account of the three first *categories*: Ταῦτα μὲν γὰρ, ὡς μὲν ἡ οὐσία. ὁμοία δ' ἂν ἡ ποσότης μὲν ἴσθαι δὲ, ὡς τὸ ποσόν ἐν. "Things are the same, of which the substance is one; similar, of which the quality is one; equal, of which the quantity is one. Again, he tells us*, that the chief characteristic of quantity is, that it may be denominated *equal* ³Prad. ⁴P. 34. edit. ⁵Sylb. and unequal.

That any man can become wiser by reading such descriptions as these, none but an idolater of Aristotle will suppose. There is, indeed, no periphrasis by which we can explain what is meant by quantity to those who have not previously formed such a notion. — All that can be done by making the attempt is only to settle language, by stating exactly the cases in which we use this word in the greatest conformity to general custom; for there is a laxness or carelessness of expression in the language of most men, and our notions are frequently communicated by speech in a way by no means precise; so that it is often a great chance that the notions excited in the mind of the hearer are not exact counterparts of those in the mind of the speaker.

Quantity. The understandings of men differ in nothing more remarkably than in their power of abstraction, and of rapidly forming conceptions so general and simple as not to be clogged with distinguishing circumstances, which may be different in different minds while uttering and hearing the same words: and it is of great consequence to a man of scientific habits, either to cultivate, if possible, this talent, or to supersede its use, by studiously forming to himself notions of the most important *universals* in his own course of contemplation, by careful abstraction of every thing extraneous. His language by this means becomes doubly instructive by its extreme precision; and he will even judge with greater certainty of notions intended to be communicated by the more slovenly language of another person.

We cannot say that there is much ambiguity in the general use of the term *quantity*: But here, as in all other cases, a love of refinement, of novelty, and frequently of vanity, and the wish of appearing ingenious and original, have made men take advantage of even the small latitude with which the careless use of the word will furnish them, to amuse themselves and the public by giving the appearance of science to empty sounds.

³
The subject of mathematical reasoning
Mathematics is undoubtedly employed in discovering and stating many relations of quantity; and it is in this category alone that any thing is contemplated by the mathematician, whether in geometry, arithmetic, or algebra. Hence mathematics has been called the science of quantity. The simplicity of the object of the mathematician's contemplation, and the unparalleled distinctness with which he can perceive its modifications, have enabled him to erect a body of science, eminent not only for its certainty, but also for the great length to which he can carry his reasonings without danger of error; and the intimate connection which this science has with the arts of life, and the important services which it has performed, have procured it a most respectable place in the circle of the sciences. Ingenious men have availed themselves of this pre-eminence of mathematics, and have endeavoured to procure respect for their disquisitions on other subjects, by presenting them to the public as branches of mathematical science, and therefore susceptible of that accuracy and certainty which are its peculiar boast. Our moral affections, our sensations, our intellectual powers, are all susceptible of augmentation and diminution, are conceivable as greater and less when stated together, and are familiarly spoken of as admitting of degrees of comparison. We are perfectly well understood when we say that one pain, heat, grief, kindness, is greater than another; and as this is the distinguishing characteristic of quantity, and as quantity is the subject of mathematical discussion, we suppose that these subjects may be treated mathematically. Accordingly, a very celebrated and excellent philosopher* has said, among many things of the same

kind, that the greatness of a favour is in the direct compound ratio of the service performed and the dignity of the performer, and the inverse ratio of the merit and rank of the receiver; that the value of a character is in the compound ratio of the talents and virtue, &c.; and he has delivered a number of formal propositions on the most interesting questions in morals, couched in this mathematical language, and even expressed by algebraic formulae. But this is mere play, and conveys no instruction. We understand the words; they contain no absurdity; and in as far as they have a sense, we believe the propositions to be true. But they give no greater precision to our sentiments than the more usual expressions would do. If we attend closely to the meaning of any one of such propositions, we shall find that it only expresses some vague and indistinct notions of degrees of those emotions, sentiments, or qualities, which would be just as well conceived by means of the expressions of ordinary language; and that it is only by a sort of analogy or resemblance that this mathematical language conveys any notions whatever of the subjects.

⁵
The object of contemplation to the mathematician is not whatever is susceptible of greater and less, but what is measurable; and mathematics is not the science of magnitude, in its most abstracted and general acceptation, but of magnitude which can be measured. It is, indeed, the science of measure, and whatever is treated in the way of mensuration is treated mathematically. Now, in the discourse of ordinary life and ordinary men, many things are called quantities which we cannot or *do not* measure. This is the case in the instances already given of the affections of the mind, pleasure, pain, beauty, wisdom, honour, &c. We do not say that they are incapable of measure; but we have not yet been able to measure them, nor do we think of measuring them when we speak rationally and usefully about them. We therefore do not consider them mathematically; nor can we introduce mathematical precision into our discussions of these subjects till we can, and actually do, measure them. Persons who are precise in their expression will even avoid such phrases on these subjects as suppose, or strictly express, such measurement. We should be much embarrassed how to answer the question, How much pain does the toothache give you just now; and how much is it easier since yesterday? Yet the answer (if we had a measure) would be as easy as to the question, How many guineas did you win at cards? or how much land have you bought? Nay, though we say familiarly, "I know well how much such a misfortune would affect you," and are understood when we say it, it would be awkward language to say, "I know well the quantity of your grief." It is in vain, therefore, to expect mathematical precision in our discourse or conceptions of quantities in the most abstracted sense. Such precision is confined to quantity which may be and is measured (A). It is only

* Dr Francis Hutcheson.

(A) To talk intelligibly of the quantity of a pain, we should have some standard by which to measure it; some known degree of it so well ascertained, that all men, when talking of it, should mean the same thing.— And we should be able to compare other degrees of pain with this, so as to perceive distinctly, not only whether they exceed or fall short of it, but also how much, or in what proportion; whether by an half, or a fifth, or tenth. Reid.

Quantity. only trifling with the imagination when we employ mathematical language on subjects which have not this property.

6
Measuring explained.

It will therefore be of some service in science to discriminate quantities in this view; to point out what are susceptible of measure, and what are not.

What is measuring? It is one of these two things: It is either finding out some known magnitude of the thing measured, which we can demonstrate to be equal to it; or to find a known magnitude of it, which being taken so many times shall be equal to it. The geometer measures the contents of a parabolic space when he exhibits a parallelogram of known dimensions, and demonstrates that this parallelogram is equal to the parabolic space. In like manner, he measures the solid contents of an infinitely extended hyperbolic spindle, when he exhibits a cone of known dimensions, and demonstrates that three of these cones are equal to the spindle.

In this process it will be found that he actually subdivides the quantity to be measured into parts of which it consists, and states these parts as actually making up the quantity, specifying each, and assigning its boundaries. He goes on with it, piece by piece, demonstrating the respective equalities as he goes along, till he has exhausted the figure, or considered all its parts. — When he measures by means of a submultiple, as when he shows the surface of a sphere to be equal to four of its great circles, he stops, after having demonstrated the equality of one of these circles to one part of the surface: then he demonstrates that there are other three parts, each of which is precisely equal to the one he has minutely considered. In this part of the process he expressly assigns the whole surface into its distinct portions, of which he demonstrates the equality.

But there is another kind of geometrical measurement which proceeds on a very different principle. The geometer conceives a certain individual portion of his figure, whether line, angle, surface, or solid, as known in respect to its dimensions. He conceives this to be lifted from its place, and again laid down on the *adjoining* part of the figure, and that it is equal to the part which it now covers; and therefore that this part together with the first is double of the first: he lifts it again, and lays it down on the next adjoining part, and affirms that this, added to the two former, make up a quantity triple of the first. He goes on in this way, making similar inferences, till he can demonstrate that he has in this manner covered the whole figure by twenty applications, and that his moveable figure will cover no more; and he affirms that the figure is twenty times the part employed.

7
Euclid's fourth proposition.

This mode is precisely similar to the manner of practical measurement in common life: we apply a foot-rule successively to two lines, and find that 30 applications exhaust the one, while it requires 35 to exhaust the other. We say, therefore, that the one line is 30 and the other 35 feet long; and that these two lines are to each other in the ratio of 30 to 35. Having measured two shorter lines by a similar application of a stick of an inch long 30 times to the one and 35 times to the other, we say that the ratio of the two first lines is the same with that of the two last. Euclid has taken this method of demonstrating the fourth proposition of the first book of his celebrated elements.

But all this process is a fiction of the mind, and it is the fiction of an impossibility. It is even *inconceivable*,

that is, we cannot in imagination make this application of one figure to another; and we presume to say, that, if the elements of geometry cannot be demonstrated in some other way, the science has not that title to pure, abstract, and infallible knowledge, which is usually allowed it. We cannot *suppose* one of the triangles lifted and laid on the other, without supposing it something different from a triangle in *abstracto*. The *individuality* of such a triangle consists solely in its being in the precise place where it is, and in occupying *that* portion of space. If we could distinctly conceive otherwise, we should perceive that, when we have lifted the triangle from its place, and applied it to the other, it is gone from its former place, and that there is no longer a triangle *there*. This is inconceivable, and space has always been acknowledged to be immoveable. There is therefore some logical defect in Euclid's demonstration. We apprehend that he is labouring to demonstrate, or rather illustrate, a simple apprehension. This indeed is the utmost that can be done in any demonstration (see *METAPHYSICS*, n° 82.); but the mode by which he guides the mind to the apprehension of the truth of his fourth proposition is not consistent either with pure mathematics or with the laws of corporeal nature. The real process, as laid down by him, seems to be this. We suppose something different from the abstract triangle; some *thing* that, in conjunction with other properties, has the property of being triangular, with certain dimensions of two of its sides and the included angle. It has avowedly another property, not essential to, and not contained in, the abstract notion of a triangle, *viz.* mobility. We also suppose it permanent in shape and dimensions, or that although, *during* its motion, it does not occupy *the same space*, it continues, and all its parts, to occupy *an equal space*. In short, our conception is very mixed, and does not perceptibly differ from our conception of a triangular piece of matter, where the triangle is not the subject, but an adjunct, a quality. And when we suppose the application made, we are not in fact supposing two abstract triangles to coincide. This we cannot do with any thing like distinctness; for our distinct conception now is, not that of two triangles coinciding, but of one triangle being now exactly occupied by that moveable thing which formerly occupied the other. In short, it is a vulgar measurement, restricted by suppositions which are inadmissible in all *actual* measurements in the present universe, in which no moveable material thing is *known* to be permanent, either in shape or magnitude.

This is an undeniable consequence of the principle of universal gravitation, and the compressibility of every kind of tangible matter with which we are acquainted. Remove the brass rule but one inch from its place; its gravitation to the earth and to the rest of the universe is immediately changed, and its dimensions change of consequence. A change of temperature will produce a similar effect; and this is attended to and considered in all nice mensurations. We do the best we can to assure ourselves that our rule always occupies a sensibly equal space; and we must be contented with chances of error which we can neither perceive nor remove.

We might (were this a proper place) take notice of some other logical defects in the reasoning of this celebrated proposition: but they are beside our present purpose of explaining the different modes of mathematical

Quantity.

Quantity. cal measurement, with the view of discovering that circumstance in which they all agree, and which (if the only one) must therefore be the characteristic of mensuration.

8
The characteristic notion of mensuration.

We think that the only circumstance in which all modes of mensuration agree, or the only notion that is found in them all, is, that the quantity is conceived as consisting of parts, distinguishable from each other, and separated by assignable boundaries; so that they are at once conceived separately and jointly. We venture to assert that no quantity is directly measured which we cannot conceive in this way, and that such quantities only are the immediate objects of mathematical contemplation, and should be distinguished by a generic name. Let them be called MATHEMATICAL QUANTITIES. EXTENSION, DURATION, NUMBER, and PROPORTION, have this characteristic, and they are the only quantities which have it. Any person will be convinced of the first assertion by attending to his own thoughts when contemplating these notions. He will find that he conceives every one of them as made up of its own parts, which are distinguishable from each other, and have assignable boundaries, and that it is only in consequence of involving this conception that they can be added to or subtracted from each other; that they can be multiplied, divided, and conceived in any proportion to each other.

He may perhaps find considerable difficulty in acquiring perfectly distinct notions of the mensurability, and the accuracy of the modes of mensuration. He will find that the way in which he measures duration is very similar to that in which he measures space or extension. He does not know, or does not attend to, any thing which hinders the brass foot-rule in his hand from continuing to occupy equal spaces during his use of it, in measuring the distance of two bodies. In like manner he selects an event which nature or art can repeat continually, and in which the circumstances which contribute to its accomplishment are invariably the same, or their variations and their effects are insensible. He concludes that it will always occupy an equal portion of time for its accomplishment, or always last an equal time. Then, observing that, during the event whose duration he wishes to measure, this standard event is accomplished $29\frac{1}{2}$ times, and that it is repeated $365\frac{1}{4}$ times during the accomplishment of another event, he affirms that the durations of these are in the ratio of $29\frac{1}{2}$ to $365\frac{1}{4}$. It is thus (and with the same logical defect as in the measuring a line by a brass rod) that the astronomer measures the celestial revolutions by means of the rotation of the earth round its axis, or by the vibrations of a pendulum.

9
Characters of mathematical quantity.

We are indebted for most of the preceding observations to Dr Reid, the celebrated author of the Inquiry into the Human Mind on the Principles of Common Sense, and of the Essays on the intellectual and active Powers of Man. He has published a dissertation on this subject in the 45th volume of the Philosophical Transactions, n^o 489, which we recommend to our philosophical readers as a performance eminent for precision and acuteness. If we presume to differ from him in any trivial circumstance, it is with that deference and respect which is due to his talents and his worth.

Dr Reid justly observes, that as nothing has proportion which has not either extension, duration, or num-

ber, the characters of mathematical quantity may be restricted to these three. He calls them PROPER quantities, and all others he calls IMPROPER. We believe that, in the utmost precision of the English language, this denomination is very apposite, and that the word *quantity*, derived from *quantum*, always supposes measurement: But the word is frequently used in cases where its original is not kept in view, and we use other words as synonymous with it, when all mensuration, whether possible or not, is out of our thoughts. According to practice, therefore, the *jus et norma loquendi*, there seems to be no impropriety in giving this name, in our language at least, to whatever can be conceived as great or little. There is no impropriety in saying that the pain occasioned by the stone is greater than that of the toothache; and when we search for the category to which the assertion may be referred, we cannot find any other than quantity. We may be allowed therefore to say, with almost all our scientific countrymen, that every thing is conceivable in respect of quantity which we can think or speak of as greater and less; and that this notion is the characteristic of quantity as a genus, while measureableness is the characteristic of mathematical quantity as a species.

But do we not measure many quantities, and consider them mathematically, which have not this characteristic of being made up of their own distinguishable parts? What else is the employment of the mechanician, when speaking of velocities, forces, attractions, repulsions, magnetic influence, chemical affinity, &c. &c.? Are not these mathematical sciences? And if the precision and certainty of mathematics arise from the nature of their specific object, are not all the claims of the mechanician and physical astronomer ill-founded pretensions? These questions require and deserve a serious answer.

It is most certain that we consider the notions which are expressed by these terms velocity, force, density, and the like, as susceptible of measure, and we consider them mathematically.

Some of these terms are nothing but names for relations of measurable quantity, and only require a little reflection to show themselves such. VELOCITY is one of these. It is only a name expressing a relation between the space described by a moving body and the time which elapses during its description. Certain moderate rates of motion are familiar to us. What greatly exceeds this, such as the flight of a bird when compared with our walking, excites our attention, and this excess gets a name. A motion not so rapid as we are familiar with, or as we wish, also gets a name: because in this the excess or defect may interest us. We wish for the flight of the hawk; we chide the tardy pace of our messenger: but it is scientific curiosity which first considers this relation as a *separate* object of contemplation, and the philosopher must have a name for it. He has not formed a new one, but makes use of a word of common language, whose natural meaning is the combination of a great space with a short time. Having once appropriated it, in his scientific vocabulary, to this very general use, it loses with him its true signification. Tardity would have done just as well, though its true meaning is diametrically opposite; and there is no greater impropriety in saying the tardity of a cannon bullet than in saying the velocity of the hour-hand of a watch.

Velocity

Quantity.

10
Other quantities that cannot be considered mathematically.

11
Velocity, force, density, how measured.

Quantity. Velocity is a quality or affection of motion, the notion of which includes the notions of space and duration (two mathematical quantities), and no other. It does not therefore express a mathematical quantity itself, but a relation, a combination of two mathematical quantities of different kinds; and as it is measurable in the quantities so combined, its measure must be a unit of its own kind, that is, an unit of space *as combined* with an unit of time.

DENSITY is another word of the same kind, expressing a combination of space with number. *Dense arbores* means trees standing at a small distance from each other; and the word is used in the same sense when we say that quicksilver is denser than water. The expression always suggests to the reflecting mind the notions of particles and their distances. We are indeed so habituated to complicated views of things, that we can see remote connections with astonishing rapidity; and a very few circumstances are sufficient for leading forward the mind in a train of investigation. Common discourse is a most wonderful instance of this. It is in this way that we say, that we found by weighing them that inflammable air had not the sixth part of the density of common air. Supposing all matter to consist of equal atoms equally heavy, and knowing that the weight of a bladder of air is the sum of the weights of all the atoms, and also knowing that the *vicinity* of the atoms is in a certain proportion of the *number* contained in a given bulk, we affirm that common air is more than six times denser than inflammable air; but this rapid decision is entirely the effect of habit, which makes us familiar with certain groups of conceptions, and we instantaneously distinguish them from others, and thus think and discourse rationally. The Latin language employs the word *frequens* to express both the combination of space and number, and that of time and number.

There are perhaps a few more words which express combinations of mathematical quantities of different kinds; and the corresponding ideas or notions are therefore proper and immediate subjects of mathematical discussion: But there are many words which are expressive of things, or at least of notions, to which this way of considering them will not apply. All those affections or qualities of external bodies, by which they are conceived to act on each other, are of this kind: IMPULSIVE FORCE, WEIGHT, CENTRIPETAL and CENTRIFUGAL FORCE, MAGNETICAL, ELECTRICAL, CHEMICAL ATTRACTIONS AND REPULSIONS; in short, all that we consider as the immediate causes of natural phenomena. These we familiarly measure, and consider mathematically.

¹² Forces measured in the phenomena. *What was said on this subject in the article PHYSICS will give us clear conceptions of this process of the mind. These forces or causes are not immediate objects of contemplation, and are known only by and in the phenomena which we consider as their effects. The phenomenon is not only the indication of the agency of any cause, and the characteristic of its kind, but the measure of its degree. The necessary circumstances in this train of human thought are, 1st, The notion of the force as something susceptible of augmentation and diminution. 2d, The notion of an inseparable connection of the force with the effect produced, and of every degree of the one with a corresponding degree of the other. From these is formed the notion that the phenomenon*

or effect is the proper measure of the force or cause. *Quantity.* All this is strictly logical.

But when we are considering these subjects mathematically, the immediate objects of our contemplation are not the forces which we are thus treating. It is not their relations which we perceive, and which we combine with such complication of circumstances and certainty of inference as are unknown in all other sciences: by no means; they are the phenomena only, which are subjects of purely mathematical discussion. They are motions, which involve only the notions of space and time; and when we have finished an accurate mathematical investigation, and make our affirmation concerning the forces, we are certain of its truth, because we *suppose* the forces to have the proportions and relations, and no other, which we observe in the phenomena. Thus, after having demonstrated, by the geometrical comparison of the lines and angles and surfaces of an ellipse, that the momentary deflection of the moon from the tangent of her orbit is the 3600th part of the simultaneous deflection of a stone from the tangent of its parabolic path, Newton affirms, that the force by which a particle of the moon is retained in her orbit is the 3600th part of the weight of a particle of the stone; and having farther shown, from fact and observation, that these momentary deflections are inversely as the squares of the distances from the centre of the earth, he affirms, that all this is produced by a force which varies its intensity in this manner.

Now all this investigation proceeds on the two suppositions mentioned above, and the measures of the forces are in fact the measures of the phenomena. The whole of physical astronomy, and indeed the whole of mechanical philosophy, might be taught and understood, without ever introducing the word force, or the notion which it is supposed to express: for our mathematical reasonings are really about the phenomena, which are subjects purely mathematical.

The precision, therefore, that we presume to affirm to attend these investigations, arises entirely from the measurable nature of the quantities which are the real objects of our contemplation, and the suitableness and propriety of the measures which we adopt in our comparisons.

Since, then, the phenomena are the *immediate* subjects of our discussion, and the operating powers are only inferences from the phenomena considered as effects, the quantity ascribed to them must also be an inference from the quantity of the effect, or of some circumstance in the effect. The measure, therefore, of the cause, or natural power or force, cannot be one of its own parts; for the whole and the part are equally unperceived by us. Our measure, therefore, must be a measure of some interesting part, or of the only interesting part of the phenomenon. It is therefore in a manner arbitrary, and depends chiefly on the interest we take in the phenomenon. It must, however, be settled with precision, so that all men in using it may mean the same thing. It must be settled, therefore, by the description of that part or circumstance of the phenomenon which is characteristic of the natural power. This description is the *definition* of the measure.

Thus Newton assumes as his measure of the centripetal force, the momentary deviation from uniform of centripetal force. Others, and sometimes Newton himself,

Quantity. himself, assumes the momentary change of velocity, which again is measured by *twice this deviation*. These measures, being thus selected, are always proper in a mathematical sense; and if strictly adhered to, can never lead us into any paralogism. They may, however, be physically wrong: there may not be that indissoluble connection between the phenomenon and the supposed cause. But this is no mathematical error, nor does it invalidate any of our mathematical inferences: it only makes them useless for explaining the phenomenon by the principle which we adopted; but it prepares a modification of the phenomenon for some more fortunate application of physical principles.

14
Requisites
of such
measures.

All that can be desired in the definitions or descriptions of these measures is, that they may not deviate from the ordinary use of the terms, because this would always create confusion, and occasion mistakes. Dr Reid has given an example of an impropriety of this kind, which has been the subject of much debate among the writers on natural philosophy. We mean the measure of the force inherent in a body in motion. Descartes, and all the writers of his time, assumed the velocity produced in a body as the measure of the force which produces it; and observing that a body, in consequence of its being in motion, produces changes in the state or motion of other bodies, and that these changes are in the proportion of the velocity of the changing body, they asserted that there is in a moving body a *VIS INSITA*, an *INHERENT FORCE*, and that this is proportional to its velocity; saying that its force is twice or thrice as great, when it moves twice or thrice as fast at one time as at another. But Leibnitz observed, that a body which moves twice as fast, rises four times as high, against the uniform action of gravity; that it penetrates four times as deep into a piece of uniform clay; that it bends four times as many springs, or a spring four times as strong, to the same degree; and produces a great many effects which are four times greater than those produced by a body which has half the initial velocity. If the velocity be triple, quadruple, &c. the effects are nine times, 16 times, &c. greater; and, in short, are proportional, not to the velocity, but to its square. This observation had been made before by Dr Hooke, who has enumerated a prodigious variety of important cases in which this proportion of effect is observed. Leibnitz, therefore, affirmed, that the force inherent in a moving body is proportional to the square of the velocity.

15
Controversy
between
the Cartesi-
ans and
Leibnitzi-
ans on this
subject.

It is evident that a body, moving with the same velocity, has the same inherent force, whether this be employed to move another body, to bend springs, to rise in opposition to gravity, or to penetrate a mass of soft matter. Therefore these measures, which are so widely different, while each is agreeable to a numerous class of facts, are not measures of this something inherent in the moving body which we call its force, but are the measures of its exertions when modified according to the circumstances of the case; or, to speak still more cautiously and securely, they are the measures of certain classes of phenomena consequent on the action of a moving body. It is in vain, therefore, to attempt to support either of them by a demonstration. The measure itself is nothing but a definition. The Cartesian calls that a double force which produces a double velocity in the body on which it acts. The Leibnitzian calls

that a quadruple force which makes a quadruple penetration. The reasonings of both in the demonstration of a proposition in dynamics may be the same, as also the result, though expressed in different numbers.

But the two measures are far from being equally proper: for the Leibnitzian measure obliges us to do continual violence to the common use of words. When two bodies moving in opposite directions meet, strike each other, and stop, all men will say that their forces are equal, because they have the best test of equality which we can devise. Or when two bodies in motion strike the parts of a machine, such as the opposite arms of a lever, and are thus brought completely to rest, we and all men will pronounce their mutual energies by the intervention of the machine to be equal. Now, in all these cases, it is well known that a perfect equality is found in the products of the quantities of matter and velocity. Thus a ball of two pounds, moving with the velocity of four feet in a second, will stop a ball of eight pounds moving with the velocity of one foot per second. But the followers of Leibnitz say, that the force of the first ball is four times that of the second.

All parties are agreed in calling gravity a uniform or invariable accelerating force; and the definition which they give of such a force is, that it always produces the same acceleration, that is, equal accelerations in equal times, and *therefore* produces augmentations of velocity proportionable to the times in which they are produced. The only effect ascribed to this force, and consequently the only thing which indicates, characterises, and measures it, is the augmentation of velocity. What is this velocity, considered not merely as a mathematical term, but as a phenomenon, as an event, a production by the operation of a natural cause? It cannot be conceived any other way than as a *determination* to move on for ever at a certain rate, if nothing shall change it. We cannot conceive this very clearly. We feel ourselves forced to animate, as it were, the body, and give it not only a will and intention to move in this manner, but a real exertion of some faculty in consequence of this determination of mind. We are conscious of such a train of operations in ourselves; and the last step of this train is the exertion or energy of some natural *faculty*, which we, in the utmost propriety of language, call force. By such analogical conception, we suppose a something, an energy, inherent in the moving body; and its only office is the production and continuation of this motion, as in our own case. Scientific curiosity was among our latest wants, and language was formed long before its appearance: as we formed analogical conceptions, we contented ourselves with the words already familiar to us, and to this something we gave the name *FORCE*, which expressed that energy in ourselves which bears some resemblance (in office at least) to the determination of a body to move on at a certain rate. This sort of allegory pervades the whole of our conceptions of natural operations, and we can hardly think or speak of any operation without a language, which supposes the animation of matter. And, in the present case, there are so many points of resemblance between the effects of our exertions and the operations of nature, that the language is most expressive, and has the strongest appearance of propriety. By exerting our force, we not only move and keep in motion, but we move other bodies. Just so a ball not only moves,

Quantity.

Quantity. but puts other bodies in motion, or penetrates them, &c.—This is the origin of that conception which so forcibly obtrudes itself into our thoughts, that there is inherent in a moving body a force by which it produces changes in other bodies. No such thing appears in the same body if it be not in motion. We therefore conclude, that it is the production of the moving force, whatever that has been. If so, it must be conceived as proportional to its producing cause. Now this force, thus produced or exerted in the moving body, is only another way of conceiving that determination which we call velocity, when it is conceived as a natural event. We can form no other notion of it. The *vis infinita*, the determination to move at a certain rate, and the velocity, are one and the same thing, considered in different relations.

16
Vis infinita.

Therefore the *vis infinita corpori moventi*, the determination to move at a certain rate, and the velocity, should have one and the same measure, or any one of them may be taken for the measure of the other. The velocity being an object of perception, is therefore a proper measure of the inherent force; and the propriety is more evident by the perfect agreement of this use of the words with common language. For we conceive and express the action of gravity as uniform, when we think and say that its effects are proportional to the times of its action. Now all agree, that the velocity produced by gravity is proportional to the time of its action. And thus the measure of force, in reference to its producing cause, perfectly agrees with its measure, independent of this consideration.

But this agreement is totally lost in the Leibnitzian doctrine; for the body which has fallen four times as far, and has sustained the action of gravity twice as long, is said to have four times the force.

The quaintness and continual paradox of expression which this measure of inherent force leads us into, would have quickly exploded it, had it not been that its chief abettors were leagued in a keen and acrimonious warfare with the British mathematicians who supported the claim of Sir Isaac Newton to the invention of fluxions. They rejoiced to find in the elegant writings of Huyghens a physical principle of great extent, such as this is, which could be set in comparison with some of the wonderful discoveries in Newton's Principia. The fact, that in the mutual actions of bodies on each other the products of the masses and the squares of the velocities remain always the same (which they call the *conservatio virium vivarum*), is of almost universal extent; and the knowledge of it enabled them to give ready and elegant solutions of the most abstruse and intricate problem, by which they acquired a great and deserved celebrity. Dr Robert Hooke, whose observation hardly any thing escaped, was the first (long before Huyghens) who remarked*, that in all the cases of the gradual production and extinction of motion, the sensible phenomenon is proportional to the square of the produced or extinguished velocity.

John Bernoulli brought all these facts together, and systematized them according to the principle advanced by Huyghens in his treatise on the centre of oscillation. He and Daniel Bernoulli gave most beautiful specimens of the prodigious use of this principle for the solution of difficult physical problems in their dissertations on the motion and impulse of fluids, and on the commu-

nication of motion. It was however very early objected to them (we think by Marquis Poleni), that in the collision of bodies perfectly hard there was no such *conservatio virium vivarum*; and that, in this case, the forces must be acknowledged to be proportional to the velocities. The objections were unanswerable.—But John Bernoulli evaded their force, by affirming that there were and could be no bodies perfectly hard. This was the origin of another celebrated doctrine, on which Leibnitz greatly plumed himself, THE LAW OF CONTINUITY, viz. that nothing is observed to change abruptly, or *per saltum*. But no one will pretend to say that a perfectly hard body is an inconceivable thing; on the contrary, all will allow that softness and compressibility are adjunct ideas, and not in the least necessary to the conception of a particle of matter, nay totally incompatible with our notion of an ultimate atom.

Sir Isaac Newton never could be provoked to engage in this dispute. He always considered it as a wilful abuse of words, and unworthy of his attention. He guarded against all possibility of cavil, by giving the most precise and perspicuous definitions of those measures of forces, and all other quantities which he had occasion to consider, and by carefully adhering to them. And in one proposition of about 20 lines, viz. the 39th of the 1st book of the Principia, he explained every phenomenon adduced in support of the Leibnitzian doctrine, showing them to be immediate consequences of the action of a force measured by the velocity which it produces or extinguishes. There it appears that the heights to which bodies will rise in opposition to the uniform action of gravity are as the squares of the initial velocities: So are the depths to which they will penetrate uniformly resisting matter: So is the number of equal springs which they will bend to the same degree, &c. &c. &c. We have had frequent occasion to mention this proposition as the most extensively useful of all Newton's discoveries. It is this which gives the immediate application of mechanical principles to the explanation of natural phenomena. It is incessantly employed in every problem by the very persons who hold by the other measure of forces, although such conduct is virtually giving up that measure. They all adopt, in every investigation, the two theorems $ft = v$, and $fs = v^2$; both of which suppose an accelerating force f proportional to the velocity v which it produces by its uniform action during the time t , and the theorem $ffs = v^2$ is the 39th 1. Princip. and is the *conservatio virium vivarum*.

This famous dispute (the only one in the circle of mathematical science) has led us somewhat aside. But we have little more to remark with respect to measurable quantity. We cannot say what varieties of quantity are susceptible of strict measure, or that it is impossible to give accurate measures of every thing susceptible of augmentation and diminution. We affirm, however, with confidence, that pain, pleasure, joy, &c. are not made up of their own parts, which can be contemplated separately: but they may chance to be associated by nature with something that is measurable; and we may one day be able to assign their degrees with as much precision as we now ascertain the degrees of warmth by the expansion of the fluid in the thermometer. There is one sense in which they may all be

Quantity.
18
Law of continuity.

19
Great superiority of Newton.

17
Conservatio virium vivarum.

* *Micographia*, vis res-
finitiva,
&c. in his
Posthumous
Works.

Quantity be measured, viz. numerically, as Newton measures density, *vis motrix*, &c. We can conceive the pain of each of a dozen men to be the same. Then it is evident that the pain of eight of these men is to that of the remaining four as two to one; but from such menuration we do not foresee any benefit likely to arise.

QUANTITY, in grammar, an affection of a syllable, whereby its measure, or the time wherein it is pronounced, is ascertained; or that which determines the syllable to be long or short.

Quantity is also the object of prosody, and distinguishes verse from prose; and the economy and arrangement of quantities, that is, the distribution of long and short syllables, makes what we call the *number*. See POETRY, Part III.

The quantities are used to be distinguished, among grammarians, by the characters, short, as *për*; and —, long, as *rôs*. There is also a common, variable, or dubious quantity; that is, syllables that are one time taken for short ones, and at another time for long ones; as the first syllable in *Atlas*, *patres*, &c.

QUARANTINE, is a trial which ships must undergo when suspected of a pestilential infection. It may be ordered by the king, with advice of the privy-council, at such times, and under such regulations, as he judges proper. Ships ordered on quarantine must repair to the place appointed, and must continue there during the time prescribed (generally six weeks); and must have no intercourse with the shore, except for necessary provisions, which are conveyed with every possible precaution. When the time is expired, and the goods opened and exposed to the air as directed, if there be no appearance of infection they are admitted to port.

Ships infected with the pestilence must proceed to St Helen's Pool in the Scilly islands, and give notice of their situation to the customhouse officers, and wait till the king's pleasure be known.

Persons giving false information to avoid performing quarantine, or refusing to go to the place appointed, or escaping, also officers appointed to see quarantine performed, deserting their office, neglecting their duty, or giving a false certificate, suffer death as felons.

Goods from Turkey, or the Levant, may not be landed without license from the king, or certificate that they have been landed and aired at some foreign port. See PLAGUE.

QUARLES (Francis), the son of James Quarles clerk to the board of green cloth and purveyor to queen Elisabeth, was born in 1592. He was educated at Cambridge; became a member of Lincoln's inn; and was for some time cup-bearer to the Queen of Bohemia, and chronologer to the city of London. It was probably on the ruin of her affairs that he went to Ireland as secretary to archbishop Usher; but the troubles in that kingdom forcing him to return, and not finding affairs more at peace in England, some disquiets he met with were thought to have hastened his death, which happened in 1644. His works both in prose and verse are numerous, and were formerly in great esteem, particularly his Divine Emblems: but the obsolete quaintness of his style has caused them to fall into neglect, excepting among particular classes of readers.

“The memory of Quarles, says a late author, has been branded with more than common abuse, and he seems to have been censured merely from the want of being read.”

Madley's
select beauties of
Ancient English
Poetry.

If his poetry failed to gain him friends and readers, his piety should at least have secured him peace and goodwill. He too often, no doubt, mistook the enthusiasm of devotion for the inspiration of fancy; to mix the waters of Jordan and Helicon in the same cup, was reserved for the hand of Milton; and for him, and him only, to find the bays of Mount Olivet equally verdant with those of Parnassus. Yet, as the effusions of a real poetical mind, however thwarted by untowardness of subject, will be seldom rendered totally abortive, we find in Quarles original imagery, striking sentiment, fertility of expression, and happy combinations; together with a compression of style that merits the observation of the writers of verse. Gross deficiencies of judgment, and the infelicity of his subjects, concurred in ruining him. Perhaps no circumstance whatever can give a more complete idea of Quarles's degradation than a late edition of his Emblems; the following passage is extracted from the preface: “Mr Francis Quarles, the author of the Emblems that go under his name, was a man of the most exemplary piety, and had a deep insight into the mysteries of our holy religion. But, for all that, the book itself is written in so old a language, that many parts of it are scarce intelligible in the present age; many of his phrases are so affected, that no person, who has any taste for reading, can peruse them with the least degree of pleasure; many of his expressions are harsh, and sometimes whole lines are included in a parenthesis, by which the mind of the reader is diverted from the principal object. His Latin mottos under each cut can be of no service to an ordinary reader, because he cannot understand them. In order, therefore, to accommodate the public with an edition of Quarles's Emblems properly modernised, this work was undertaken.” Such an exhibition of Quarles is chaining Columbus to an oar, or making John Duke of Marlborough a train-band corporal.”

QUARRIES, a name commonly given to a most extraordinary cavern under the city of Paris, the existence of which is known to few even of the inhabitants, and many of those who have heard of it consider the whole as an idle story. Mr Thomas White, however, member of the Royal Medical Society of Edinburgh, &c. who visited it in 1784, puts the matter beyond a doubt; having, with many others, obtained leave (which is very cautiously granted) to inspect it, having guides and torches with them. He gives the following account of it in the second volume of the Manchester Transactions. “At the entrance by the *Observatoire Royal*, the path is narrow for a considerable way; but soon we entered large and spacious streets, all marked with names, the same as in the city; different advertisements and bills were found, as we proceeded, pasted on the walls, so that it had every appearance of a large town swallowed up in the earth.

“The general height of the roof is about 9 or 10 feet; but in some parts not less than 30 and even 40. In many places there is a liquor continually dropping from it, which congeals immediately, and forms a species of transparent stone, but not so fine and clear as rock crystal. As we continued our peregrination, we thought ourselves in no small danger from the roof, which we found but indifferently propped in some places with wood much decayed. Under the houses, and many of the streets, however, it seemed to be tolerably secured by immense stones set in mortar; in other parts, where

Quarries. there are only fields or gardens above, it was totally unsupported for a considerable space, the roof being perfectly level, or a plane piece of rock. After travelling about two miles, we again descended about 20 steps, and here found some workmen in a very cold and damp place, propping up a most dangerous part, which they were fearful would give way every moment. The path here is not more than three feet in width, and the roof so low, that we were obliged to stoop considerably.

"On walking some little distance farther, we entered into a kind of saloon cut out of the rock, and said to be exactly under the *Eglise de St Jacques*. This was illuminated with great taste, occasioned an agreeable surprise, and made us all amply amends for the danger and difficulty we had just before gone through. At one end was a representation in miniature of some of the principal forts in the Indies, with the fortifications, draw-bridges, &c. Cannons were planted with a couple of soldiers to each ready to fire. Centinels were placed in different parts of the garrison, particularly before the governor's house; and a regiment of armed men was drawn up in another place with their general in the front. The whole was made up of a kind of clay which the place affords, was ingeniously contrived, and the light that was thrown upon it gave it a very pretty effect.

"On the other side of this hall was a long table set out with cold tongues, bread, and butter, and some of the best Burgundy I ever drank. Now every thing was hilarity and mirth; our fears were entirely dispelled, and the danger we dreaded the moment before was now no longer thought of. In short, we were all in good spirits again, and proceeded on our journey about two miles farther, when our guides judged it prudent for us to ascend, as we were then got to the steps which lead up to the town. We here found ourselves safe at the *Val de Grace*, near to the English Benedictine convent, without the least accident having happened to any one of the party. We imagined we had walked about two French leagues, and were absent from the surface of the earth betwixt four and five hours.

"There were formerly several openings into the quarries, but the two I have mentioned, viz. the *Observatory* and the *Val de Grace*, are, I believe, the only ones left; and these the inspectors keep constantly locked, and rarely open them, except to strangers particularly introduced, and to workmen who are always employed in some part by the king. The police thought it a necessary precaution to secure all the entrances into this cavern, from its having been formerly inhabited by a famous gang of robbers, who infested the country for many miles round the city of Paris.

"As to the origin of this quarry, I could not, on the strictest inquiry, learn any thing satisfactory; and the only account I know published is the following contained in the *Tableaux de Paris, nouvelle edition, tom premier, chapitre 5me, page 12me*.

"For the first building of Paris it was necessary to get the stone in the environs; and the consumption of it was very considerable. As Paris was enlarged, the suburbs were insensibly built on the ancient quarries, so that all that you see without is essentially wanting in the earth for the foundation of the city: hence proceed the frightful cavities which are at this time

found under the houses in several quarters. They stand upon abysses. It would not require a very violent shock to throw back the stones to the place from whence they have been raised with so much difficulty. Eight men being swallowed up in a gulph 150 feet deep, and some other less known accidents, excited at length the vigilance of the police and the government, and, in fact, the buildings of several quarters have been privately propped up; and by this means a support given to these obscure subterraneous places which they before wanted.

"All the suburbs of St James's, Harp-street, and even the street of Tournon, stand upon the ancient quarries; and pillars have been erected to support the weight of the houses. What a subject for reflections, in considering this great city formed and supported by means absolutely contrary! These towers, these steeples, the arched roofs of these temples, are so many signs to tell the eye that what we now see in the air is wanting under our feet."

QUARRY, a place under ground, out of which are got marble, freestone, slate, limestone, or other matters proper for building. See **STRATA**.

Some limestone quarries in Fife are highly worthy the attention of the curious, on account of an amazing mixture of sea-bodies found in them. One of this kind was opened about the year 1759, at a farm called *Enderteel*, in the neighbourhood of Kirkaldy, belonging to General St Clair.

The flakes of the stone, which are of unequal thickness, most of them from eight to ten inches, lie horizontally, dipping towards the sea. Each of these flakes, when broken, presents to our view an amazing collection of petrified sea bodies, as the bones of fishes, stalks of sea-weed, vast quantities of shells, such as are commonly found on those coasts, besides several others of very uncommon figures. In some places the shells are so numerous, that little else is to be seen but prodigious clusters or concretions of them. In the uppermost stratum the shells are so entire, that the outer crust or plate may be scraped off with the finger; and the stalks of the sea-weed have a darkish colour, not that glossy whiteness which they have in the heart of the quarry. The smallest rays or veins of the shells are deeply indented on the stone, like the impression of a seal upon wax. In short, no spot at the bottom of the ocean could exhibit a greater quantity of sea-bodies than are to be found in this solid rock; for we have the skeletons of several fishes, the *antenna* or feelers of lobsters, the roots and stalks of sea-weeds, with the very *capsula* which contain the seed. The place where all these curiosities are found is on an eminence about an English mile from the sea; and as the ground is pretty steep the whole way, it may be 200 feet higher at least.

There are two or three things to be remarked here. 1. That among all the bodies we have mentioned, there are none but what are specifically heavier than water. This holds so constantly true, that the sea-weed, which floats in water when the plant is entire, has been stripped of the broad leaves, which make it buoyant, before it has been lodged here. 2. The shells have been all empty; for the double ones, as those of the flat kind, are always found single, or with one side only. 3. The rock seems to have been gradually deserted

Quarry
||
Quarter.

ferted by the sea, and for a long time, washed with the tides; for the upper surface is all eaten, and hollowed in many places like an honey-comb, just as we observe in flat rocks exposed every tide to the access and recess of the waters. See the article SEA.

QUARRY, or *Quarrel*, among glaziers, a pane of glass cut in a diamond form.

Quarries are of two kinds, square and long; each of which are of different sizes, expressed by the number of the pieces that make a foot of glass, viz. eighths, tenths, eighteenth, and twentieths: but all the sizes are cut to the same angles, the acute angle in the square quarrels being $77^{\circ} 19'$, and $67^{\circ} 21'$ in the long ones.

QUARRY, among hunters, is sometimes used for a part of the entrails of the beast taken, given by way of reward to the hounds.

QUARRY, in falconry, is the game which the hawk is in pursuit of, or has killed.

QUARTAN, a measure containing the fourth part of some other measure.

QUARTAN, a species of intermitting fever. See MEDICINE, n^o 153, 158, and 159.

QUARTATION, is an operation by which the quantity of one thing is made equal to a fourth part of the quantity of another thing. Thus when gold alloyed with silver is to be parted, we are obliged to facilitate the action of the aquafortis, by reducing the quantity of the former of these metals to one fourth part of the whole mass; which is done by sufficiently increasing the quantity of the silver, if it be necessary. This operation is called *quartation*, and is preparatory to the parting; and even many authors extend this name to the operation of parting. See the article PARTING.

QUARTER, the fourth part of any thing, the fractional expression for which is $\frac{1}{4}$.

QUARTER, in weights, is generally used for the fourth part of an hundred weight avoirdupois, or 28 lb.

Used as the name of a dry measure, *quarter* is the fourth part of a ton in weight, or eight bushels.

QUARTER, a term in the manege. To work from quarter to quarter, is to ride a horse three times in upon the first of the four lines of a square; then changing your hand, to ride him three times upon the second: and so to the third and fourth; always changing hands, and observing the same order.

QUARTERS, with respect to the parts of a horse, is used in various senses: thus the shoulders and fore-legs are called the *fore-quarters*, and the hips and hinder-legs the *hind-quarters*. The *quarters* of a horse's foot are the sides of the coffin, comprehending between the toe and the heel: the *inner quarters* are those opposite to one another, facing from one foot to the other; and these are always weaker than the *outside quarters*, which lie on the external sides of the coffin. *False quarters*, are a cleft in the horn of a horse's hoof, extending from the coronet to the shoe. A horse is said to be *quarter-cast*, when for any disorder in the coffin we are obliged to cut one of the quarters of the hoof.

QUARTER, in astronomy, the fourth part of the moon's period: thus, from the new moon to the quadrature is the first quarter; from this to full moon, the second quarter, &c.

QUARTER, in heraldry, is applied to the parts or

members of the first division of a coat that is quartered, or divided into four quarters. Quarter.

Franc QUARTER, in heraldry, is a quarter single or alone; which is to possess one fourth part of the field. It makes one of the honourable ordinaries of a coat.

QUARTER of a Ship, that part of the ship's side which lies towards the stern; or which is comprehended between the aftmost end of the main chains and the sides of the stern, where it is terminated by the quarter-pieces.

Although the lines by which the quarter and bow of a ship, with respect to her length, are only imaginary, yet experience appears sufficiently to have ascertained their limits: so that if we were to divide the ship's sides into five equal portions, the names of each space would be readily enough expressed. Thus the first, from the stern, would be the quarter; the second, abaft the midships; the third, the midships; the fourth, before the midships; and the fifth, the bow. Whether these divisions, which in reality are somewhat arbitrary, are altogether improper, may be readily discovered by referring to the mutual situation or approach of two adjacent vessels. The enemy boarded us on the larboard side! Whereabouts? Abaft the midships, before the midships, &c.

Plate CCCCXXVII. n^o 1. represents a geometrical elevation of a quarter of a 74 gun ship. A the keel, with a the false keel beneath it. B the stern-post. DD the quarter-gallery, with its ballustrades and windows. EE the quarter-pieces, which limit and form the outlines of the stern. F the taffarel, or upper pieces of the stern. FG the profile of the stern, with its galleries. H the gun-ports of the lower-deck; h the gun-ports of the upper and quarter-deck. I the after-part of the mizen-channel. K the wing-transom. KG the lower counter. LB the station of the deck-transom. LQ the after-part of the main-wale. DR the after-part of the channel-wale, parallel to the main-wale. SU the sheer-rail, parallel to both wales. T the rudder. A I F the rake of the stern. Pii the drift-rails. TU the after-part of the load *water-line*; k k l the curve of the several decks corresponding to those represented in the head. See the article HEAD.

As the marks, by which vessels of different constructions are distinguished from each other, are generally more conspicuous on the stern or quarter than any other part, we have represented some of the quarters, which assume the most different shapes, and form the greatest contrast with each other. N^o 2. shows the stern and quarter of a Dutch sloop. N^o 3. the stern and quarter of a cat. N^o 4. is the stern and quarter of a common galley. N^o 5. exhibits the quarter of a first-rate galley, otherwise called a *galleasse*. N^o 6. the quarter of a Dutch dogger, or galliot. N^o 7. represents the stern and quarter of a sloop of war.

The quarters of all other ships have a near affinity to those above exhibited. Thus all ships of the line, and East-Indiamen, are formed with a quarter little differing from the principal figure in this plate. Xebecs have quarters nearly resembling those of galleasses, only somewhat higher. Hagboats and pinks approach the figure of cats, the former being a little broader in the stern, and the latter a little narrower; and the sterns and quarters of cats seem to be derived from those of fly-boats.

Quarter.

boats. The sterns of Dutch doggers and galliots are indeed singular, and like those of no other modern vessel: they have nevertheless a great resemblance to the ships of the ancient Grecians, as represented in medals and other monuments of antiquity.

On the *QUARTER*, may be defined an arch of the horizon, contained between the line prolonged from the ship's stern and any distant object, as land, ships, &c. Thus if the ship's keel lies on an east and west line, the stern being westward, any distant object perceived on the north-west or south-west, is said to be on the larboard or starboard quarter.

QUARTER-Bill, a roll, or list, containing the different stations, to which all the officers and crew of the ship are quartered in the time of battle, and the names of all the persons appointed to those stations. See *QUARTERS*.

QUARTER-Master, is an officer, generally a lieutenant, whose principal business is to look after the quarters of the soldiers, their clothing, bread, ammunition, firing, &c. Every regiment of foot and artillery has a quarter-master, and every troop of horse one, who are only warrant-officers, except in the Blues.

QUARTER-Master-General, is a considerable officer in the army; and should be a man of great judgment and experience, and well skilled in geography. His duty is to mark the marches and encampments of an army: he should know the country perfectly well, with its rivers, plains, marshes, woods, mountains, defiles, passages, &c. even to the smallest brook. Prior to a march, he receives the order and route from the commanding general, and appoints a place for the quarter-masters of the army to meet him next morning, with whom he marches to the next camp; where being come, and having viewed the ground, he marks out to the regimental quarter-masters the ground allowed each regiment for their camp: he chooses the head-quarters, and appoints the villages for the generals of the army's quarters: he appoints a proper place for the encampment of the train of artillery: he conducts foraging parties, as likewise the troops to cover them against assaults, and has a share in regulating the winter-quarters and cantonments.

QUARTER-Netting, a sort of net-work, extended along the rails on the upper part of a ship's quarter. In a ship of war these are always double, being supported by iron cranes, placed at proper distances. The interval is sometimes filled with cork, or old sails; but chiefly with the hammocks of the sailors, so as to form a parapet to prevent the execution of the enemy's small arms in battle.

QUARTER-Sessions, a general court held quarterly by the justices of peace of each county. This court is appointed by stat. 2 Hen. V. c. 4. to be in the first week after Michaelmas-day; the first week after the Epiphany; the first week after the close of Easter; and in the week after the translation of Saint Thomas a Becket, or the 7th of July. This court is held before two or more justices of the peace, one of whom must be of the *quorum*. The jurisdiction of this court by 34 Ed. III. c. 1. extends to the trying and determining of all felonies and trespasses whatsoever, though they seldom, if ever, try any greater offence than small fe-

lonies within the benefit of clergy, their commission providing, that if any case of difficulty arises, they shall not proceed to judgment, but in the presence of one of the justices of the courts of king's bench or common pleas, or one of the judges of assize. And therefore murderers and other capital felons are usually remitted for a more solemn trial to the assizes. They cannot also try any new-created offence, without express power given them by the statute which creates it. But there are many offences, and particular matters, which by particular statutes belong properly to this jurisdiction, and ought to be prosecuted in this court; as, the smaller misdemeanors against the public or commonwealth, not amounting to felony, and especially offences relating to the game, highways, alehouses, bastard children, the settlement and provision for the poor, vagrants, servants wages, apprentices, and popish recusants. Some of these are proceeded upon by indictment, and others in a summary way by motion and order thereupon; which order may, for the most part, unless guarded against by particular statutes, be removed into the court of king's bench, by writ of *certiorari facias*, and be there either quashed or confirmed. The records or rolls of the sessions are committed to the custody of a special officer, denominated the *custos rotulorum*. In most corporation towns there are quarter-sessions kept before justices of their own, within their respective limits, which have exactly the same authority as the general quarter-sessions of the county, except in very few instances: one of the most considerable of which is the matter of appeals from orders of removal of the poor, which, though they be from the orders of corporation justices, must be to the sessions of the county, by 8 and 9 Will. III. c. 30. In both corporations and counties at large, there is sometimes kept a special or petty session, by a few justices, for dispatching smaller business in the neighbourhood between the times of the general sessions, as for licensing alehouses, passing the accounts of parish-officers, and the like.

QUARTER-Staff, a long staff borne by foresters, park-keepers, &c. as a badge of their office, and occasionally used as a weapon.

QUARTERS, a name given at sea to the several stations where the officers and crew of a ship of war are posted in action. See *Naval TACTICS*.

The number of men appointed to manage the artillery is always in proportion to the nature of the guns, and the number and condition of the ship's crew. They are, in general, as follow, when the ship is well manned, so as to fight both sides at once occasionally:

Pounder.	No. of men.	Pounder.	No. of men.
To a 42	- 15	To a 9	- 6
32	- 13	6	- 5
24	- 11	4	- 4
18	- 9	3	- 3
12	- 7		

This number, to which is often added a boy to bring powder to every gun, may be occasionally reduced, and the guns nevertheless well managed. The number of men appointed to the small arms, on board his Majesty's ships and sloop of war, by order of the admiralty, are,

Quarter.
Quarters.

Quarters
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Quarto.

Rate of the ship.	No. of men to the small arms.
1st - - -	150
2d - - -	120
3d of 80 guns - -	100
— of 70 guns - -	80
4th of 60 guns - -	70
4th of 50 guns - -	60
5th - - -	50
6th - - -	40
Sloops of war - -	30

The lieutenants are usually stationed to command the different batteries, and direct their efforts against the enemy. The master superintends the movements of the ship, and whatever relates to the sails. The boatswain, and a sufficient number of men, is stationed to repair the damaged rigging; and the gunner and carpenter, wherever necessary, according to their respective offices.

The marines are generally quartered on the poop and forecastle, or gang-way, under the direction of their officers; although, on some occasions, they assist at the great guns, particularly in distant cannonading.

QUARTERS, at a siege, the encampment upon one of the most principal passages round a place besieged, to prevent relief and convoys.

Head QUARTERS of an Army, the place where the commander in chief has his quarters. The quarters of generals of horse are, if possible, in villages behind the right and left wings, and the generals of foot are often in the same place: but the commander in chief should be near the centre of the army.

QUARTERS of Refreshment, the place or places where troops that have been much harassed are put to recover themselves during some part of the campaign.

Intrrenched QUARTERS, a place fortified with a ditch and parapet to secure a body of troops.

Winter QUARTERS, sometimes means the space of time included between leaving the camp and taking the field; but more properly the places where the troops are quartered during the winter.

The first business, after the army is in winter-quarters, is to form the chain of troops to cover the quarters well: which is done either behind a river, under cover of a range of strong posts, or under the protection of fortified towns. Hussars are very useful on this service.

It should be observed, as an invariable maxim, in winter-quarters, that your regiments be disposed in brigades, to be always under the eye of a general officer; and, if possible, let the regiments be so distributed, as to be each under the command of its own chief.

QUARTERING, in heraldry, is dividing a coat into four or more quarters, or quarterings, by partitioning, coupling, &c. that is, by perpendicular and horizontal lines, &c.

QUARTO-DECIMANS, an ancient sect in the Christian church, who taught that Easter should always be celebrated according to the custom of the Jews, on the fourteenth day of the moon in the month of March, whensoever that day fell out. And hence they derived their name *quarto de imani*, q. d. Fourteenthers. The Asiatics were mightily attached to this opinion, pre-

tending that it was built on the authority of St John, who was their apostle; and pope Victor could never bring them to obedience in this article, though he was upon the point of excommunicating them: but it is more probable he contented himself with menaces. See EASTER.

QUARTZ, a genus of siliceous earths very common in Europe. According to Kirwan, the quartz are in general the purest of the siliceous kind, though most of them contain a slight mixture of other earths: the most obvious distinction among them arises from their opacity or transparency. Cronstedt gives the following characteristics of it: 1. It is generally cracked throughout, even in the rock itself, whereby, as well as by its own nature, it breaks into irregular and sharp fragments. 2. It cannot be easily made red hot, without cracking still more. 3. It never decays in the air. 4. Melted with fixed alkali in a due proportion, it gives a more solid and fixed glass than any of the other siliceous stones. 5. When there has been no interruption in its natural accretion, it always crystallizes into hexagonal prisms pointed at both ends. 6. It is met with in clefts, fissures, and small veins in rocks; it seldom forms large veins, and still more rarely whole mountains, without a mixture of heterogeneous substances. It is found,

1. Pure, of several varieties, as, (1.) Solid, or having no visible particles, and called *fat quartz*. This is either transparent, white, blue, or violet-coloured. The first kind is met with in the copper-mines in the northern part of Norway and Siberia, and has no regular form, but is as clear as the finest crystallized quartz, or rock crystal. (2.) *Grained quartz*, of a white or pale green colour, found in various places in Sweden. (3.) The *sparry quartz*, which is the scarcest of the whole, and ought not to be confounded with the white felt-spar, because it is of a smoother appearance, and breaks into larger and more irregular planes. It is found of a whitish yellow, from the gold mines in Hungary; or white, from the island of Uto. Brunnich tells us, that the Hungarian gold and silver mines near Hodentch, which have veins frequently some fathoms wide, afford a kind of lamellated and porous quartz. It is met with of white, yellow, and blue colours, and it is sometimes finely crystallized in pyramidal figures.

2. *Crystallized quartz*, or *rock crystal*. See CRYSTAL.

3. *Impure quartz*. Of this there are two kinds, (1.) Mixed with iron, in form of a black calx. It is black, glossy, and contains a great quantity of iron. It is found in Sweden. (2.) Mixed with copper, and of a red colour, found in the same country.

Cronstedt observes, that quartz in general, and especially its crystals, are very commonly supposed, when yet in their soft and dissolved state, to have included within them some vegetables, for instance grass and moss. "This (says he) I cannot absolutely deny; but it deserves carefully to be examined if that which is shown as a grass be not an asbestos, or a striated cockle; and the moss only branched varieties filled with earth, which, by their being ramose, bear a vegetable appearance. It is very common in agates, and makes them of less value than they otherwise would be. This is most generally the case with those stones which are shown as including vegetables; and, for my own part, I have

Quartz.

Quartz
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Quasi.

have never been so fortunate as to meet with any others."

M. Magellan remarks, that quartz is one of the principal kinds of stone which contain metals. Some of the Hungarian veins consist entirely of it, and the gold is so minutely dispersed, that it cannot be discerned by the best microscopes before it is separated by pounding and washing. The width of the veins, some of which are half a fathom, and some still more, repay the trouble and expences, which the small quantity of gold would not otherwise counterbalance. Nature has not anywhere produced mountains of pure quartz; for though some rocks in Sweden are ranked among the quartzes, they are undoubtedly mixed with heterogeneous matters. Near Lauterberg upon the Hartz are veins of this stone from one to three fathoms wide, consisting of a loose sand, in which they find the copper ore in nests. In the Danish isle of Anhalt we meet with triangular quartz pebbles. There are likewise crystals of quartz having water inclosed in them; some fine pieces of this kind are to be met with in the Imperial cabinet at Vienna, &c.

Rock crystals are generally found upon or among quartz, and are to be met with in all parts of the world. The greatest number are furnished to the European countries from Mount Saint Gothard in Switzerland.—Here large pieces, weighing from 5 to 800 pounds, were found at Grimselberg; one of 1200 pounds was found some years ago at Filsbach in the Wallais; and a piece six feet long, four broad, and equally thick, was found in the island of Madagascar, a place where these natural productions are of the most extraordinary size and perfection.

When great quantities of quartz are continually agitated by the sea or river water, they are sometimes reduced to such very minute parts as to be easily carried away, suspended in the water; and there are sands of so minute a size as to measure less than the two or three hundredth part of an inch. These are called *quicksands*. Immense tracts of land consist only of loose sands, particularly along the sea-shore in many parts of Europe. Some suppose that sea-water has the power of producing this sand out of its own substance; and their surfaces, in general, are so polished, as to show that they could not be reduced in size by rubbing against each other; but we know not as yet that such a production has ever been demonstrated. When sand is about as big as peas, it is called gravel; and when it is free from saline and heterogeneous particles, it is employed in making mortar, and other economical purposes. That which is very pure serves for making flint-glass, with red calces of lead, and the proper alkaline flux; but when mixed with ferruginous black sand, the glass assumes a greenish black colour. "This (says M. Magellan) I have seen among the various specimens of glass made by Mr E. Delaval, F. R. S. who produced a very fine transparent and colourless glass out of the same sand with which he had made some of that black glass, and this only by separating from it all the ferruginous mixture."

QUASHING, in law, the overthrowing and annulling a thing.

QUASI-CONTRACT, in the civil law, an act without the strict form of a contract, but yet having the force thereof. In a contract there must be the mutual consent of both parties, but in a *quasi-contract* one party

may be bound or obligated to the other, without having given his consent to the act whereby he is obliged. For example: I have done your business, in your absence, without your procuration, and it has succeeded to your advantage. I have then an action against you for the recovery of what I have disbursed, and you an action against me to make me give an account of my administration, which amounts to a *quasi-contract*.

Quasi-Crime, or *Quasi-deliâ*, in the civil law, the action of a person who does damage, or evil, involuntarily. The reparation of *quasi-crimes* consists in making good the damages, with interest.

QUASS, a fermented liquor drunk in Russia. See PEASANT.

QUASSIA, in botany: A genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the 14th order, *Gruinales*. The calyx is pentaphyllous; there are five petals; the nectarium is pentaphyllous; there are from two to five seed-cases standing asunder, and monospermous. There are three species, the *amara*, *simaruba*, and *excelsa* or *polygama*.

The quassia amara grows to the height of several feet, and sends off many strong branches. The wood is of a white colour and light; the bark is thin and grey: the leaves are placed alternately on the branches, and consist of two pair of opposite pinnae, with an odd one at the end: all the leaflets are of an elliptical shape, entire, veined, smooth, pointed, sessile, on the upper pagina of a deep green colour, on the under paler: the common footstalk is articulated, and winged, or edged, on each side with a leafy membrane, which gradually expands towards the base of the pinnae: the flowers are all hermaphrodite, of a bright red colour, and terminate the branches in long spikes: the bractæ or floral leaves are lance-shaped or linear, coloured, and placed alternately upon the peduncles: the calyx is small, persistent, and five-toothed: the corolla consists of five lance-shaped equal petals, at the base of which is placed the nectary, or five roundish, coloured, scales: the filaments are ten, slender, somewhat longer than the corolla, and crowned with simple antheræ, placed transversely: the receptacle is fleshy and orbicular: the germen is ovate, divided into five parts, and supports a slender style, longer than the filaments, and terminated by a tapering stigma: the capules are five, two-celled, and contain globular seeds. It is a native of South America, particularly of Surinam, and also of some of the West Indian islands. The root, bark, and wood, of this tree have all places in the materia medica. The wood is most generally used, and is said to be a tonic, stomachic, antiseptic, and febrifuge.

The quassia simaruba is common in all the woodlands in Jamaica. It grows to a great height and considerable thickness. The trunks of the old trees are black and a little furrowed. Those of the young trees are smooth and gray, with here and there a broad yellow spot. The inside bark of the trunk and branches is white, fibrous, and tough. It tastes slightly bitter. On cutting or stripping off this bark, no milky juice issues, as has been mentioned by various authors. The wood is hard, and useful for buildings. It splits freely, and makes excellent staves for sugar hogsheds. It has no sensible bitter taste. The branches are alternate and spreading. The leaves are numerous and alternate. On the upper side, they are smooth, shining, and of a deep

Quasi
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Quassia.

Woodville's
Medical Bo-
tany, vol. ii.
p. 215.

Dr Wright's
Paper, Edin.
Transf.
vol. ii.

Quassia. deep green colour : on the under side they are white. The flowers appear about the beginning of April. They are of a yellow colour, and placed on spikes beautifully branched.

The fruit is of that kind called a *drupa*, and is ripe towards the end of May. It is of an oval shape, is black, smooth, and shining. The pulp is fleshy and soft ; the taste is nauseous sweet. The nut is flattened, and on one side winged. The kernel is small, flat, and tastes sweet. The natural number of these drupæ is five on each common receptacle ; but, for the most part, there are only two or three ; the rest abort by various accidents. The roots are thick, and run superficially under the surface of the ground to a considerable distance. The bark is rough, scaly, and warted. The inside when fresh is a full yellow, but when dry paler. It has but little smell. The taste is bitter, but not very disagreeable. This is the true cortex simarubæ of the shops. This tree is known in Jamaica by the names of *mountain damson*, *bitter damson*, and *slave-wood*. The shops are supplied with this bark from Guiana ; but now we may have it from our own islands at a moderate expence. On examining the fructification, Dr Wright found this tree to be a species of quassia. Under that name he sent it to Europe, and Linnæus adopted it into his system. There are male flowers on one tree and female flowers on another ; and this is invariably the case in Jamaica.

Most authors who have written on the simaruba agree, that in fluxes it restores the lost tone of the intestines, allays their spasmodic motions, promotes the secretions by urine and perspiration, removes that low-ness of spirits attending dysenteries, and disposes the patient to sleep ; the gripes and tenesmus are taken off, and the stools are changed to their natural colour and consistence. In a moderate dose, it occasions no disturbance or uneasiness ; but in a large doze it produces sickness at stomach and vomiting. Negroes are less affected by it than white people. Dr Cullen, however, says,

Materia Medica, v. l. ii. p. 75. " We can perceive nothing in this bark but that of a simple bitter ; the virtues ascribed to it in dysentery have not been confirmed by my experience, or that of the practitioners in this country ; and leaving what others are said to have experienced to be further examined and considered by practitioners, I can only at present say, that my account of the effect of bitters will perhaps explain the virtues ascribed to simaruba. In dysentery I have found an infusion of chamomile flowers a more useful remedy." The quassia excelsa or polygama was named by Sir Joseph Banks, Dr Solander, and Dr Wright, *pricrania amara*, (see *PRICRANIA Amara*.) It is ranked, however, by Mr John Lindsay, in a paper in the third volume of the Edinburgh Transactions, under *quassia*, who gives the following description of it. " It is very common in the woodlands of Jamaica, is beautiful, tall, and stately, some of them being 100 feet long, and ten feet in circumference eight feet above the ground. The trunk is straight, smooth, and tapering, sending off its branches towards the top. The outside bark is pretty smooth, of a light gray or ash colour, from various lichens. The bark of the roots is of a yellow cast, somewhat like the cortex simaruba. The inner bark is tough, and composed of fine flaxy fibres. The wood is of a yellow colour, tough, but not very hard. It takes a good polish, and is used

Vol. XV. Part II.

as flooring. The leaves are sub-alternate ; the small leaves are in pairs, from five to eight, standing opposite to each other on short footstalks, and ending with an odd one. They are of an oblong oval shape, and pointed ; the ribs reddish, and the young leaves are covered with a fine brownish down. The flowers come out in bunches or clusters from the lower part of the last shoot before the leaves, and stand on round footstalks. The flowers are small, of a yellowish green colour, with a very small calyx. The male or barren tree has flowers nearly similar to the hermaphrodite, but in it there are only the rudiments of a style.

" The fruit is a smooth black drupa, round-shaped, and of the size of a pea. There is but little pulp, and the nut covers a round kernel. These drupæ are generally three, sometimes two, and often only one, attached sidewise to a roundish fleshy receptacle. It flowers in October and November, and its fruit is ripe in December and January. Except the pulp of the fruit, every other part of this tree has an intensely bitter taste. In taste and virtues it is nearly equal to the quassia of Surinam, and I am credibly informed is sold in London for the quassia amara ; and it may be safely used in all cases where that drug has been thought proper, whether as an antiseptic, or in cases of weakness in the stomach and bowels. It may either be given alone, or joined with the Jesuit's bark. The happiest effects result from the use of this medicine in obdurate remitting fevers from marsh miasmata, in agues which had resisted the use of Jesuit's bark, and in dysenteries of long standing. It is in daily practice in dropsies from debility, either in simple infusions or tincture by itself, or joined with aromatics and chalybeates. Dr Drummond, an eminent physician in Jamaica, prescribes it with great success in the above cases, as well as in amenorrhæa, chlorosis, dyspepsia, and in that species of pica called *dirteating*, so fatal to a number of negroes.

" The bark of the quassia polygama, but especially the wood, is intensely bitter. They may both be used in various forms. In certain cases of dropsy, aromatics and preparations are joined to it, also in amenorrhæa and chlorosis ; and in worm fevers, the cabbage-bark, or other vegetable anthelmintics."

QUATUORVIR, in antiquity, formerly written III. VIR, a Roman magistrate, who had three colleagues joined with him in the same administration, and had the care of conducting and settling the colonies sent into the provinces. There were also quatuorviri appointed to inspect and take care of repairs, &c.

QUAVER, in music, a measure of time equal to half a crotchet, or an eighth part of a semibreve.

QUAY. See KEY.

QUEBEC, a handsome and large town of America, and capital of Canada. The first place taken notice of upon landing here is a square of an irregular figure, with well-built houses on each side ; on the back of which is a rock ; on the left it is bounded by a small church ; and on the right are two rows of houses, parallel to each other. There is another between the church and the harbour ; as also another long row on the side of the bay. This may be looked upon as a kind of suburb ; and between this and the great street is a very steep ascent, in which they have made steps for the foot-passengers to go up. This may be called the

Quassia

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Quebec.

Quebec
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Queen.

the *Upper Town*, wherein is the bishop's palace; and between two large squares is a fort where the governor lodges. The Recolets have handsome houses over-against it, and on the right is the cathedral church: over-against this is the Jesuits college, and between them are well-built houses; from the fort runs two streets, which are crossed by a third, and between these is a church and a convent. In the second square are two descents to the river of St Charles. The Hotel Dieu is in the midway; and from thence are small houses, which reach to the house of the intendant. On the other side of the Jesuits college, where the church stands, is a pretty long street in which is a nunnery. Almost all the houses are built of stone, and there are about 7000 inhabitants; the fort is a handsome building, but not quite finished. Quebec is not regularly fortified: but it cannot be easily taken; for the harbour is flanked with two bastions, which at high tides are almost level with the water. A little above one of the bastions is a demi-bastion, partly taken out of the rock; and above it, on the side of the gallery of the fort, is a battery of 25 pieces of cannon: still above this is a square fort called the *citadel*; and the ways from one fortification to another are difficult to pass. To the left of the harbour, on the side of the road, there are large batteries of cannon, and some mortars; besides these, there are several other fortifications not very easy to be described. In 1711 the British fitted out a fleet with a design to conquer Canada, which failed on account of the rashness of the admiral; who, contrary to the advice of his pilot, went too near the Seven isles, and so lost his largest ships, and 3000 of his best soldiers. It is about 300 miles north-west of Boston in New-England. On October 18. 1759, it was taken by the British under the command of General Wolfe, who lost his life in the battle, after he had the satisfaction to know that our troops were victorious. Admiral Saunders commanded a squadron of men of war, and did immense service in reducing this place; there being not a man in the navy but what was active on this occasion, not excepting the sailors belonging to the transport vessels. After this valuable acquisition, all Canada came under the jurisdiction of the crown of Great Britain. W. Long. 69. 48. N. Lat. 46. 55.

QUEDA, a kingdom of Asia, in the peninsula beyond the Ganges, and near the strait of Malacca. The king is tributary to Siam. The principal town is of the same name, and said to contain about 8000 inhabitants; and is subject to the Dutch. It has a harbour, and is 300 miles north of Malacca. E. Long. 100. 5. N. Lat. 7. 5.

QUEDLINGBURG, a town of Germany, in the circle of Upper Saxony, and on the confines of the duchy of Brunswick. Here is a famous abbey, whose abbess is a princess of the empire, and who sends deputies to the diets. Her contingent is one horseman and ten footmen. The inhabitants of the town live by brewing, husbandry, and feeding of cattle. It is 10 miles south-east of Halberstadt, and 32 west of Bernberg. E. Long. 11. 34. N. Lat. 52. 1.

QUEEN, a woman who holds a crown singly.

The title of *queen* is also given by way of courtesy to her that is married to a king, who is called by way of distinction *queen-consort*; the former being termed *queen-regent*. The widow of a king is also called *queen*,

but with the addition of *dowager*. See *Royal-Family*.

QUEEN Charlotte's Sound, is situated at the northern extremity of the southern island of New Zealand, near Cook's Strait, lying in 41. 6. of south latitude, and 174. 19. of east longitude. The climate of this sound is much more mild than at Dusky Bay; and though there is not such plenty of wild fowl and fish, the defect is sufficiently compensated by abundance of excellent vegetables. The hills about the sound consist mostly of an argillaceous stone of a greenish grey, or bluish or yellowish brown colour. A green talkous or nephritic (by the jewellers called *jade*) is likewise very common, together with horn-stone, shingle, several sorts of flinty stones and pebbles, some loose pieces of basalt, strata of a compact mica or glimmer, with particles of quartz. Hence, Mr Forrester thinks, there is reason to believe that this part of New Zealand contains iron-ore, and perhaps several other metallic substances. The country is not so steep as at Dusky Bay, and the hills near the sea are generally inferior in height, but covered with forests equally intricate and impenetrable. Captain Cook sowed the seeds of many vegetables in this place, that have useful and nutritive roots. He sowed also corn of several sorts, beans, kidney-beans, and pease. The dogs here are of the long-haired sort, with pricked ears, and resemble the common shepherd's cur, but they are very stupid animals. They are fed with fish, and even dogs flesh, and perhaps human flesh, which the natives also eat. Captains Cook and Furneaux left on these islands a boar and two sows, with a pair of goats, male and female, with some geese, in order to benefit the natives and future generations of navigators. They left likewise among them a number of brass medals gilt, on one side of which was the head of his present majesty, with the inscription George III. King of Great Britain, France, and Ireland, &c. On the reverse, a representation of two men of war, with the names Resolution and Adventure over them; and the exergue, sailed from England March MDCCCLXXII.

QUEEN-Gold, is a royal duty or revenue belonging to every queen of England during her marriage to the king, payable by persons in this kingdom and Ireland, on divers grants of the king by way of fine or oblation, &c. being one full tenth part above the entire fines, on pardons, contracts, or agreements, which becomes a real debt to the queen, by the name of *aurum regine*, upon the party's bare agreement with the king for his fine, and recording the same.

QUEEN's-County, a division of the province of Leinster in Ireland; so called from the popish Queen Mary, in whose reign it was first made a county by the earl of Suffex, then lord-deputy. It is bounded on the south by Kilkenny and Catherlogh; by King's county on the north and west; part of Kildare and Catherlogh on the east; and part of Tipperary on the west. Its greatest length from north to south is 35 miles, and its breadth near as much; but it is unequal both ways. This county was anciently full of bogs and woods, though now pretty well inclosed, cultivated, and inhabited. The baronies contained in it are seven; and it sends eight members to parliament.

QUEEN-Bee. See *BEE*, n^o 3. &c.

QUEENBOROUGH, a town of the isle of Shep.

Queen
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Queenbo-
rough.

Queens-
ferry
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Quercus.

pey in Kent, which sends two members to parliament, though consisting only of about 100 low brick houses, and scarce 350 inhabitants. The chief employment of the people here is oyster drudging; oysters being very plentiful, and of a fine flavour. E. Long. o. 50. N. Lat. 51. 25.

QUEENS-FERRY, a town of Scotland, in the shire of Lothian, seated on the south side of the river Forth, 9 miles west of Edinburgh.

Großer's
General De-
scription of
China.

QUEI-LING-FOU, the capital of the province of Quangsi in China, has its name from a flower called *quei*, which grows on a tree resembling a laurel; it exhales so sweet and agreeable an odour, that the whole country around is perfumed with it. It is situated on the banks of a river, which throws itself into the Taho; but it flows with such rapidity, and amidst so narrow valleys, that it is neither navigable nor of any utility to commerce. This city is large, and the whole of it is built almost after the model of our ancient fortresses; but it is much inferior to the greater part of the capitals of the other provinces. A great number of birds are found in the territories belonging to it, the colours of which are so bright and variegated, that the artists of this country, in order to add to the lustre of their silks, interweave with them some of their feathers, which have a splendour and beauty that cannot be imitated. Quei-ling has under its jurisdiction two cities of the second class and seven of the third.

QUEI, in natural history, is a name given by the Chinese to a peculiar earth found in many parts of the east. It is of the nature of an indurated clay, and in some degree approaches to the talcs, as our steatites and the galactites do. It is very white and absterfivc, used by the women of China to take off spots from the skin, and render it soft and smooth, as the Italian ladies use talk of Venice. They sometimes use the fine powder of this stone dry, rubbing it on the hands and face after washing; sometimes they mix it in pomatum.

QUERCI, a province of Guienne in France; bounded on the north by Limosin, on the east by Rouergue and Auvergne, on the south by Upper Languedoc, and on the west by Agenois and Perigord. It is divided into Upper and Lower; and is fertile in corn, wine, and fruits. Cahors is the capital town.

QUERCUS, the OAK-TREE: A genus of the polyandria order, belonging to the monoecia class of plants; and in the natural method ranking under the 50th order, *Amentacea*. The calyx is nearly quinquefid; there is no corolla; the stamina are from five to ten in number. The female calyx is monophyllous, very entire, and scabrous. There is no corolla; the styles are from two to five; and there is an ovate seed. See OAK.

Species. 1. The robur, or common English oak, grows from about 60 or 70 to 100 feet high, with a prodigious large trunk, and monstrous spreading head; oblong leaves, broadest towards the top, the edges acutely sinuated, having the angles obtuse. There is a variety, having the leaves finely striped with white. This species grows in great abundance all over England, in woods, forests, and hedge-rows; is naturally of an amazing large growth; there being accounts of some above 100 feet stature, with wonderful large trunks and spreading heads; and is supposed to continue its growth many centuries.

2. The prinus, or chestnut-leaved American oak, *Quercus*. grows 50 or 60 feet high; having large oblong-oval smooth leaves pointed both ways, the edges sinuated-ferrated, with the sinuses uniformly round.

3. The phellos, or willow-leaved American oak, grows 40 or 50 feet high, having long narrow smooth entire leaves, like those of the willow. There is a variety called the *dwarf willow-leaved oak*.

4. The alba, or white Virginian oak, grows 30 or 40 feet high, having a whitish bark, with long obliquely-pinnatifid light-green leaves, the sinuses and angles obtuse.

5. The nigra, or black Virginian oak, grows 30 or 40 feet high, having a dark-coloured bark, large wedge-shaped slightly-trilobated leaves.

6. The rubra, or red Virginian oak, grows about 60 feet high, having a dark-greyish bark, long obtusely-sinuated leaves, with the sinuses terminated by bristly points, and have sometimes red spotted veins, but generally dyeing in autumn to a reddish colour, remaining on the trees late in the season.

7. The esculus of Pliny, or cut-leaved Italian oak, grows about 30 feet high, having a purplish bark, oblong deeply-sinuated smooth leaves, and long slender close-fitting acorns in very large cups.

8. *Ægilops*, or large prickly-cupped Spanish oak, grows 70 or 80 feet high or more, with a very large trunk, and widely-spreading head, having a whitish bark, large oblong-oval deeply-ferrated smooth leaves, the ferratures bowed backward, and large acorns placed in singularly large prickly cups. This is a noble species, almost equal in growth to our common English oak.

9. *Cerris*, or smaller prickly-cupped Spanish oak, grows 30 or 40 feet high, and has oblong lyre-shaped pinnatifid transversely-jagged leaves, downy underneath, and small acorns placed in prickly cups.

10. The ilex, or common evergreen oak, grows 40 or 50 feet high, having a smooth bark, oval and oblong undivided ferrated petiolated leaves, downy and whitish underneath. The varieties are, broad-leaved, narrow-leaved, and sometimes both sorts and other different shaped leaves on the same tree, also sometimes with sawed and prickly leaves.

11. The gramuntia, or Montpellier holly-leaved evergreen oak, grows 40 or 50 feet high; and has oblong-oval, close-fitting sinuated spinous leaves, downy underneath, bearing a resemblance to the leaves of holly.

12. The suber, or cork-tree, grows 30 or 40 feet high, having a thick, rough, fungous, cleft bark, and oblong-oval undivided ferrated leaves, downy underneath. This species furnishes that useful material cork; it being the bark of the tree, which becoming of a thick fungous nature, under which, at the same time, is formed a new bark, and the old being detached for use, the tree still lives, and the succeeding young bark becomes also of the same thick spongy nature in six or seven years, fit for barking, having likewise another fresh bark forming under it, becoming cork like the others in the like period of time; and in this manner these trees wonderfully furnish the cork for our use, and of which is made the corks for bottles, bungs for barrels, and numerous other useful articles. The tree grows in great plenty in Spain and Portugal, and from these countries we receive the cork. The Spaniards

Quercus.

burn it, to make that kind of light black we call Spanish black, used by painters. Cups made of cork are said to be good for hectic persons to drink out of. The Egyptians made coffins of cork; which being lined with a resinous composition, preserved dead bodies uncorrupted. The Spaniards line stone-walls with it, which not only renders them very warm, but corrects the moisture of the air.

13. The coccifera, scarlet, or kermes oak, grows but 14 or 15 feet high, branching all the way, and of bushy growth; with large oval, undivided, indented, spinous leaves; and producing small glandular excrescences, called *kermes* or *scarlet grain*, used by the dyers. The small scarlet glands found in this tree, is the effect of certain insects depositing their eggs betwixt the bark of the branches and leaves, causing an extravasation of the sap, and forming the excrescence or substance in question, which being dried is the kermes or scarlet pastel.

14. The Molucca, Moluccan oak, commonly called *American live oak*, grows about 40 feet high, having oval, spear-shaped, smooth, entire leaves, and small oblong eatable acorns.

All the above 14 species of quercus produce flowers annually in the spring, about April or May, of a yellowish colour, but make no ornamental appearance, and are males and females separated in the same tree; the males being in loose amentums, and the females fitting close to the buds in thick leathery hemispherical calyxes, succeeded by the fruit or acorns, which are oval nuts fixed by their base into rough permanent cups, and mostly sit quite close, and some on short footstalks, ripening in autumn; which in the common English oak is in great abundance, and often in tolerable plenty, on some of the other sorts: those of all the kinds serve for propagating their respective species; they are also excellent food for swine and deer, the common oak in particular.

Uses, &c. Oak-trees, of all the above sorts, may be employed in gardening to diversify large ornamental plantations in out-grounds, and in forming clumps in spacious lawns, parks, and other extensive opens; the evergreen kinds in particular have great merit for all ornamental purposes in gardens. But all the larger growing kinds, both deciduous and evergreens, demand esteem principally as first-rate forest-trees for their timber. The English oak, however, claims precedence as a timber-tree, for its prodigious height and bulk, and superior worth of its wood. Every possessor of considerable estates ought therefore to be particularly assiduous in raising woods of them, which is effected by sowing the acorns either in a nursery and the plants transplanted where they are to remain, or sowed at once in the places where they are always to stand. All the sorts will prosper in any middling soil and open situation, though in a loamy soil they are generally more prosperous; however, there are but few soils in which oaks will not grow; they will even thrive tolerably in gravelly, sandy, and clayey land, as may be observed in many parts of this country of the common oak.

The oak is of the utmost importance to Britain, and its cultivation deserves the utmost attention. Much, therefore, to the honour of the members of the *London Society for encouraging Arts, Manufactures, and Commerce*, they have excited particular attention to it; and many

excellent observations, drawn from practice, will be found in their Transactions. Quercus.

The propagation of the striped-leaved varieties of the common oak, and any particular variety of the other species, must be effected by grafting, as they will not continue the same from seed: the grafting may be performed upon any kind of oakling-stocks raised from the acorns, and train them for standards like the others.

The oak is remarkable for its slowness of growth, bulk, and longevity. It has been remarked that the trunk has attained to the size only of 14 inches in diameter, and of some to 20, in the space of fourscore years. As to bulk, we have an account of an oak belonging to Lord Powis, growing in Broomfield wood, near Ludlow in Shropshire, in the year 1764, the trunk of which measured 68 feet in girth, 23 in length, and which, reckoning 90 feet for the larger branches, contained in the whole 1455 feet of timber, round measure, or 29 loads and five feet, at 50 feet to a load.

The Greendale oak, &c. we have already mentioned (see OAK). In the opinion of many, the Cowthorp oak near Wetherby in Yorkshire is the father of the forest. Dr Hunter, in his edition of Evelyn, has given an engraving of it. Within three feet of the surface he says it measures 16 yards, and close to the ground 26. In 1776, though in a ruinous condition, it was 85 feet high, and its principal limb extended 16 yards from the bole. The foliage was very thin. If this measurement were taken as the dimension of the *real stem*, the size of this tree would be enormous; but, like most very large trees, its stem is short, spreading wide at the base, the roots rising above the ground like buttresses to the trunk, which is similar not to a cylinder but to the frustum of a cone. Mr Marsham says, "I found it in 1768, at four feet, 40 feet 6 inches; at five feet, 36 feet 6 inches; and at six feet, 32 feet 1 inch." In the principal dimensions then, *the size of the stem*, it is exceeded by the Bentley oak; of which the same writer gives the following account: "In 1759 the oak in Holt-Forest, near Bentley, was at 7 feet 34 feet. There is a large excrescence at 5 and 6 feet that would render the measure unfair. In 1778, this tree was increased half an inch in 19 years. It does not appear to be hollow, but by the trifling increase I conclude it not found." These dimensions, however, are exceeded by those of the Boddington oak. It grows in a piece of rich grass land, called the *Old Orchard Ground*, belonging to Boddington Manor-Farm, lying near the turnpike-road between Cheltenham and Tewksbury, in the Vale of Gloucester. The stem is remarkably collected at the root, the sides of its trunk being much more upright than those of large trees in general; and yet its circumference at the ground is about 20 paces: measuring with a two-foot rule, it is more than 18 yards. At three feet high it is 42 feet, and where smallest, *i. e.* from five to six feet high, it is 36 feet. At six feet it swells out larger, and forms an enormous head, which has been furnished with huge, and probably extensive, arms. But time and the fury of the wind have robbed it of much of its grandeur; and the greatest extent of arm in 1783 was eight yards from the stem.

In the Gentleman's Magazine for May 1794 we have an account of an oak tree growing in Penhurst park.

Quercus

park in Kent, together with an engraving. It is called the *Bear* or *Bare oak*, from being supposed to resemble that which Camden thought gave name to the county of Berkshire. The tradition at Penshurst is that it is the very tree planted on the day that the celebrated Sir Philip Sydney was born. "Some late writers (says Mr Rawlet) have questioned this, and think that to have been a different tree, which was cut down some years ago, and was indeed much larger than this. I remember being once in the hollow of the present oak with the late Sir John Cullum; and his opinion then was, that its antiquity was greater than the period assigned. But, I assure you, the tradition of this place is constant for this tree; and, in confirmation of it, an old lady of 94 years of age, now living, has told me, that all the tenants used to furnish themselves with boughs from this tree, to stick in their hats, whenever they went to meet the earls of Leicester. as was always the custom to do at the end of the park when they came to reside at their seat here. This fine old oak stands upon a plain about 500 yards from their venerable mansion, near a large piece of water called *Lancut-well*. Ben Jonson and Waller have particularly noticed it; and, from the distinguished owners of this place, it may be truly said to stand on classic ground. Within the hollow of it there is a seat, and it is capable of containing five or six persons with ease. The bark round the entrance was so much grown up, that it has lately been cut away to facilitate the access. The dimensions of the tree are these:

	Feet.	Inches.
Girth close to the ground	35	6
Ditto one foot from ditto	27	6
Ditto five feet from ditto	24	0
Height taken by shadow	73	0
Girth of lowest, but not largest, limb	6	9

With respect to longevity, Linnæus gives account of an oak 260 years old: but we have had traditions of some in England (how far to be depended upon we know not) that have attained to more than double that age. Mr Marsham, in a letter to Thomas Beever, Esq; Bath Papers, Vol. I. p. 79, makes some very ingenious calculations on the age of trees, and concludes from the increase of the Bentley oak, &c. that the Fortworth chestnut is 1100 years old.

Besides the grand purposes to which the timber is applied in navigation and architecture, and the bark in tanning of leather, there are other uses of less consequence, to which the different parts of this tree have been referred. The Highlanders use the bark to dye their yarn of a brown colour, or, mixed with copperas, of a black colour. They call the oak *the king of all the trees in the forest*; and the herdsman would think himself and his flock unfortunate if he had not a staff of it. The acorns are a good food to fatten swine and turkeys; and, after the severe winter of the year 1709, the poor people in France were miserably constrained to eat them themselves. There are, however, acorns produced from another species of oak, which are eaten to this day in Spain and Greece, with as much pleasure as chestnuts, without the dreadful compulsion of hunger.

QUERCUS Marina, the *Sea Oak*, in botany, the name of one of the broad-leaved dichotomous sea-ficus. It is not agreed, among the late botanists, what was the

sea oak of Theophrastus; and the most ancient botanists, Clusius and Cæsalpinus, suppose it to have been a species of the shrubby coralline; but that seems by no means to have been the case, since Theophrastus says his sea oak had a long, thick, and fleshy leaf; whence we may much more naturally conclude it to have been of the fucus class.

QUERIA, in botany: A genus of the trigynia order, belonging to the triandria class of plants; and in the natural method ranking under the 22d order, *Caryophylli*. The calyx is pentaphyllous; there is no corolla; the capsule is unilocular, and trivalved, with one seed. There are two species, viz *hispanica* and *canadensis*.

QUESNE (Abraham du), marquis of Quesne, admiral of the naval forces of France, and one of the greatest men of the last age, was born in Normandy in 1610. He contributed to the defeating of the naval power of Spain before Gattari; was dangerously wounded before Barcelona in 1642, and on other occasions: he went into the service of the Swedes, and became vice-admiral; gave the Danes an entire defeat, killed their admiral, and took his ship. He was recalled into France in 1647, and commanded the squadron sent to Naples. The sea-affairs of France being much fallen, he fitted out divers ships for the relief of the royal army that blocked up Bourdeaux; which was the principal cause of the surrender of the town. He was very fortunate in the last wars of Sicily, where he beat the Dutch thrice, and De Ruyter was killed. He also obliged the Algerines to sue for peace from France in a very humble manner. In short, Asia, Africa, and Europe, felt the effects of his valour. He was a Protestant; yet the king bestowed on him the land of Bouchet, and to immortalize his memory gave it the name of that great man. He died in 1688.

QUESTION, in logic, a proposition stated by way of interrogation.

QUESTION, or *Torture*. See **RACK**.

QUESTOR, or **QUÆSTOR**, in Roman antiquity, an officer who had the management of the public treasure.

The questorship was the first office any person could bear in the commonwealth, and gave a right to sit in the senate.

At first there were only two; but afterwards two others were created, to take care of the payment of the armies abroad, of selling the plunder, booty, &c. for which purpose they generally accompanied the consuls in their expeditions; on which account they were called *peregrini*, as the first and principal two were called *urbani*.

The number of questors was afterwards greatly increased. They had the keeping of the decrees of the senate: and hence came the two officers of *questor principis*, or *augurs*, sometimes called *candidatus principis*, whose office resembled in most respects that of our secretaries of state; and the *questor palatini*, answering in a great measure to our lord-chancellor.

QUEUE, in heraldry, signifies the tail of a beast: thus, if a lion be borne with a forked tail, he is blazoned double-queued.

QUEVEDO de **VILLEGAS** (Francisco), a celebrated Spanish poet, born at Madrid in 1570. He was descended from a noble family, and was made a knight.

Queia

||

Quevedo.

Quick,
Quicklime.

of St James; but was thrown into prison by order of Count Olivarez, whose administration he satirized in his verses, and was not set at liberty till after that minister's disgrace. Quevedo wrote some heroic, lyric, and facetious poems. He also composed several treatises on religious subjects, and has translated some authors into Spanish. He died in 1645. The most known of his works are, 1. *The Spanish Parnassus*. 2. *The Adventurer Buscon*. 3. *Visions of Hell Reformed*, &c. Quevedo was one of the greatest scholars and most eminent poets of his time. His youth was spent in the service of his country in Italy, where he distinguished himself with the utmost sagacity and prudence. His moral discourses prove his sound doctrine and religious sentiments, while his literary pieces display his infinite judgment and refined taste. His great knowledge of Hebrew is apparent from the report of the historian Mariana to the king, requesting that Quevedo might revise the new edition of the Bible of Arias Montanus. His translations of Epictetus and Phocylides, with his imitations of Anacreon, and other Greek authors, show how well he was versed in that language: that he was a Latin scholar, his constant correspondence, from the age of twenty, with Lipsius, Chifflet, and Scioppius, will sufficiently illustrate. As a poet, he excelled both in the serious and burlesque style, and was singularly happy in that particular turn we have since admired in Butler and Swift. His library, which consisted of about five thousand volumes, was reduced at his death to about two thousand, and is preserved in the convent of St Martin at Madrid.

QUICK, or *QUICKSET Hedge*, among gardeners, denote all live hedges, of whatever sort of plants they are composed, to distinguish them from dead hedges; but in a more strict sense of the word, it is restrained to those planted with the hawthorn, under which name those young plants or sets are sold by the nursery-gardeners who raise them for sale. See the article *HEDGES*.

QUICKLIME, a general name for all calcareous substances when deprived of their fixed air; such as chalk, limestone, oyster-shells, &c. calcined. See *CHEMISTRY*, n° 511, 748, 837, and 914.

Quicklime has the following properties. 1. It is entirely soluble in water, with which it unites so rapidly as to occasion considerable heat. When exposed to air, it imbibes moisture from thence. When united with as much water as is sufficient to make it a fluid paste, it is called *slaked lime*. Water saturated with quicklime is called *lime-water*. According to Brandt, lime-water contains about one part of quicklime to 700 or 800 parts of water. Slaked lime, or lime-water, being exposed to the atmosphere, attracts from thence particles of fixable air which float in it, by which means the quicklime is rendered mild, insoluble in water, and therefore appears on the surface of the lime-water, or of the slaked lime where this combination happens, in the state of mild or combined calcareous earth, convertible by a second calcination into quicklime, and is called *cream of lime*.

If the earth dissolved in lime-water be precipitated from thence by any substance containing fixable air, as by mild alkalis or magnesia, it will unite with this air, become mild, and resume its former weight and properties which it possessed before calcination. But if it be

precipitated from the water by means of some substance which does not contain fixable air, but which is more strongly disposed than the earth to unite with the water, for instance, spirit of wine, the earth thus precipitated will be in the state of quicklime, that is, caustic, and soluble in water.

2. Quicklime unites with acids without effervescence, which is nothing else than an extrication of the fixable air, of which quicklime has been already deprived. It nevertheless saturates as much acid as it would have done if it had not been calcined.

3. Quicklime is more powerfully disposed to unite with fixable air than fixed or volatile alkalis, or magnesia. Hence, when treated with these substances, it takes from them their fixable air, and is itself rendered mild, and restored to its original weight and properties. Thus two drams of chalk, having been by calcination reduced to one dram and eight grains of quicklime, were thrown into a filtrated solution of an ounce of mild fixed alkali in two ounces of water, and digested during some time; by which the calcareous earth became mild, and weighed one dram and 58 gr. By means of magnesia, the calcareous earth may be precipitated from lime-water; and this earth is found to be mild, and to have deprived the magnesia of its fixable air. By depriving alkalis of their fixable air, quicklime renders them more caustic and solvent, for the same reason that itself is by this privation of air rendered more caustic and powerfully solvent. This increase of causticity and dissolving power is consistent with a general rule, namely, that the more simple or less compounded any body is, that is, the less its general tendency to union is satisfied, the more disposed it is to unite with or dissolve other substances.

4. Quicklime has a disposition to unite with sulphur, with which it forms a hepar of sulphur, similar to that made by sulphur united with an alkali, and, like this, soluble in water. It is also disposed to unite with oils and with animal and vegetable matters, with respect to which it discovers a caustic and corrosive property.

5. Quicklime mixed with sand forms a mass which hardens, and is used as a cement or mortar.

All these properties of quicklime have been the objects of consideration to the chemists and philosophers; who have, as usual, been divided in their opinions on the subject. The evident resemblance of the action of quicklime to fire, has given occasion for one party to derive all the active properties of this substance from fire; while, on the other hand, its want of heat, and incapacity of setting bodies on fire, unless by an accession of water, were objections altogether insurmountable. On the other hand, those who denied the materiality of fire, and affirmed that it consists only in a motion mechanically produced among the particles of bodies, were altogether at a loss to show a reason why this motion, or any thing resembling it, should continue perhaps for months after the exciting cause is taken away. To remove this difficulty, some have had recourse to the action of a latent acid communicated to the quicklime by the fire; and which one chemist (Mr Meyer) has distinguished by the name of *acidum pingue*. But on this hypothesis it may be remarked in the first place, that the action of acids is as difficult to be explained as that of fire; and, in the second place, that as all substances, by calcination into quicklime, lose considerably of their weight,

Quicklime. weight, it seems very improbable that they should acquire an acid or any other substance which could increase their weight. Besides, from the experiments of Dr Black, it appears that the diminution of weight in calcareous substances is owing to their parting with a quantity of fixed air, the weight of which is much more considerable than that of any moisture or fatty matter they contain. The loss of this fixed air is now also universally allowed to be the reason of the causticity of the quicklime, as its superior attraction for fixed air is looked upon to be the reason why it renders fixed and volatile alkalis caustic like itself. The only question therefore can be, By what means are the calcareous earths deprived of their fixed air? To this question the answer is evident, namely, that the action of the fire expels the fixed air; and if this is the case, it is evident, that to this action of fire, continued, the caustic properties of the lime are owing.

We come now to the discussion of the question, Whether quicklime is to be considered as a pure earth, or a combination of it with something else?—Most of the chemists, since the discovery of fixed air, have been inclined to think that quicklime is a pure earth uncombined with any thing else, and that it approaches more nearly to the state of elementary earth than any other. But this opinion seems not to have a solid foundation; for there are other earths, such as the basis of alum, which, as far as they can be examined by us, are equally pure with quicklime, and yet discover not the smallest causticity, even after the most violent calcination. Besides, from the property which quicklime has of depriving alkaline salts of their fixed air, we may learn, that there exists in it, when kept by itself, a certain principle which prevents it from absorbing again the fixed air, with which it was once so closely united, except in certain circumstances. It is well known, that fixed alkalis, as well as those which are volatile, will absorb fixed air from the common atmosphere; and hence, tho' they are prepared in the most caustic state, they will in a very short time become mild by an exposure to the atmosphere; nay, it requires no small degree of care to prevent the atmosphere from having as much access to them as is necessary to change them from a caustic to a mild state. Now, as these substances thus attract the fixed air from the atmosphere, it thence appears that the atmosphere parts very readily with the fixed air which it contains. The quicklime, however, though it has a greater attraction for fixed air than the alkalis, yet does not become near so soon mild from exposure to the air as the alkalis which have less attraction than itself. Hence the necessary inference must be, that quicklime, after being once calcined, instead of attracting, repels fixed air, unless it is placed in certain circumstances, wherein the repelling power is destroyed, and the attractive power again manifests itself. Now it is manifest, that the power which originally repelled the fixed air was the action of fire; and consequently, while the quicklime refuses to attract fixed air, we must conclude that it is the same action which prevents the union. Quicklime therefore is not a pure earth, but a combination of a pure earth with fire; just as chalk, or limestone uncalcined, is not a pure earth, but a combination of a pure earth with fixed air. In all chemical trials, then, where quicklime is used, the double elective attraction will manifest itself as much as in a

combination of different salts, metals, and acids. Thus **Quicklime.** when water is poured on quicklime, the attraction between that element and earth is stronger than the attraction between earth and fire. The consequence is, that the water expels the fire, just as vitriolic acid poured upon sea-salt expels the marine acid. The fire, then, having nothing with which it can form a chemical combination, becomes sensible to the touch, first making the lime very hot, and then gradually dissipating in the atmosphere. However, as the water combines with the earth but in very small quantity, it can only expel the fire from that quantity with which it does combine; and consequently the lime still retains its caustic quality, though in a degree somewhat milder than what it was originally. We must also consider, that water itself has a considerable attraction for fire as well as for earth; and the consequence of this must be, that part of the lime will be dissolved in the water, if more of that element is added than what the earth can absorb without losing the form of a dry powder. Hence the origin of lime-water, which is only a small quantity of lime in its caustic state dissolved in a large quantity of water. This dissolution is owing to the double attraction of fire to earth and water; for as long as the water can admit the calcined earth to that intimate union with itself which is called a *chemical combination*, the earth must still retain all the causticity which the fire gives it, and dissolve in the water. When the earth is in too large quantity to be thus combined with the water, the latter is only absorbed into the pores of the earth, where by its bulk it splits the stone or calcined matter all to pieces, and reduces it to an impalpable powder, expelling a proportionable quantity of fire from those pores which it now occupies. The water, however, is capable of radically dissolving but a very small portion of calcined earth: and therefore the same quantity of quicklime will serve for preparing lime-water a great number of times over; but at last a large quantity is left, which seems to be quite inert, and has lost the properties of quicklime. Those who have tried the experiment of lixiviating lime with fresh quantities of water till it ceases to be soluble, have fixed the proportion of soluble matter in the lime at about one-third of the whole; but from Dr Black's experiments it appears that quicklime may all be dissolved in water at once, provided the water is in sufficient quantity. Its inactivity, therefore, after repeated affusions of water, must be owing to some change produced by the water; but whether this is owing to an absorption of all the fire it contained by the great quantity of water, or to a supply of fixed air given by the water, has not yet been determined by any experiment.

If, instead of pouring cold water upon quicklime, we pour that which is already heated, the absorption is much less complete; because the water, having already a superfluous quantity of heat, is resisted by that which is contained in the quicklime in a latent state; and hence it is a general observation, that hot water is less proper for slaking lime than cold. But if we pour on any acid upon quicklime which contains a great quantity of fire in a latent state, and has likewise a violent attraction for the earth, a much greater degree of heat is produced than with simple water. With the vitriolic acid, indeed, this is not so well perceived, if the common

Quicklime. mon. calcareous earths are made use of; because their insolubility in this acid diminishes its effect: but if, instead of these earths, we take magnesia newly calcined, the heat is so great, that the aqueous vapour, not having time to evaporate slowly, is driven off with a considerable explosion. If the common calcareous earths, well calcined, are dissolved in the nitrous acid, a most violent degree of heat is produced; more indeed than in any other case where a liquid is concerned: for the nitrous acid itself contains a great deal of latent heat; the quicklime does the same; and by the intimate union of the earth with the acid, all this latent heat, at least a great part of it, both in the quicklime and spirit of nitre, is displaced, and attacks the aqueous fluid, as being nearest to it; from whence it is dissipated in the air, or absorbed by the neighbouring substances. The same thing happens, only in a less degree, when the marine acid is employed.

When quicklime is mixed with a solution of mild alkali, a double decomposition, and two new compositions, take place. The quicklime may be considered as a combination of earth and fire, while the alkali in the present case acts as a combination of salt and air. These two substances, therefore, are no sooner put into such circumstances as enable them to act on each other, than the quicklime attracts the air from the alkali, and gives its own fire in exchange, which the alkali takes up, and thus is rendered caustic, while the quicklime becomes mild. Nevertheless, though the alkali here seems to have the greater attraction for fire, and the quicklime for air; yet it appears that the alkali is by no means capable of keeping the fire which it has imbibed for any length of time: for no sooner is it exposed to the action of the air, than it parts with the fire which it had imbibed, regains its air, and becomes mild. This, however, in all probability is owing to its extreme solubility in water while in a caustic state; for quicklime itself, when dissolved in water, very easily regains its fixed air, nay, even more than it contains in a natural state. See the article SALT.

On the whole, then, the properties of quicklime may be explained in a very easy manner on Dr Black's principle of latent heat. That heat consists in a latent state in quicklime, as well as in vapour, we have incontestable proofs; because, in all cases where quicklime changes its nature and becomes more mild, a degree of heat is produced, and which is always proportionable to the change made on the quicklime. In the making of quicklime, therefore, the air is expelled, and a proportional quantity of fire enters; in dissolving it in an acid, slaking, &c. an acid, air, or water, expels part of the heat, which then becomes sensible. By long exposure to the air, the heat gradually evaporates; the fixed air resumes its place; and the quicklime being thus increased in bulk, embraces those bodies very closely which lie nearest to it; inasmuch that, when mixed with sand and stones, it will harden with them almost into the solidity of a rock (see CEMENT and MORTAR). When mixed with animal or vegetable substances, it destroys or decomposes them, both by the action of its internal heat, and by its attraction for a certain acid contained in the animal substances, and an oily matter in the vegetables; and hence its property of burning cloth, though its attraction for the oily

matter just mentioned makes it an excellent whitener Quicksilver when properly applied. See BLEACHING.

QUICKSILVER, or MERCURY, one of the perfect metals, and so fusible that it cannot be reduced to a solid state but by the most intense degree of cold, scarcely, if at all, under 40° below 0 of Fahrenheit's thermometer. See CONGELATION. For the method of extracting quicksilver from its ore, &c. see METALLURGY, p. 454, and 475. For the various preparations, &c. from it, see CHEMISTRY Index at *mercury* and *quicksilver*, and PHARMACY Index at *mercury* and *quicksilver*. And for its use in medicine, see MEDICINE, n° 350, and MERCURY.

It is found, 1. Native, as in the mines of India, Friuli, Lower Aultria, Deux Ponts, &c. flowing through beds of stone, and collecting in the clefts or cavities of rocks. In these mines, however, Mr Kirwan is of opinion that it is mixed with some other metal, as the globules into which it is divided are not perfectly spherical. In Sweden and Germany it has been found united to silver in form of a hard and somewhat brittle amalgam. It has also been observed visibly diffused through masses of clay or stone, of a white, red, or blue colour, and very heavy in Spain and Idria; and in Sicily in beds of chalk.

Mines of quicksilver, however, are very rare, inasmuch that, according to the calculations of Hoffman, there is 50 times more gold got every year out of the mines than mercury and its ores. But Dr Lewis, in his notes upon Newmann, says, that Cramer suspects that Hoffman only meant five times instead of 50; but neither the Latin nor the English edition of this author expresses any such thought; on the contrary, he adopts the same opinion; and only adds, that mercury is much more frequently met with than is commonly believed; but being so volatile in the fire, it often flies off in the roasting of ores, and escapes the attention of metallurgists.

According to Newmann, the mines of Idria have produced at the rate of 231,778 pounds weight of mercury *per annum*; but those of Almaden in Spain produce much more. The chemists of Dijon inform us, that their annual produce is five or six thousand quintals, or between five and six hundred thousand pounds weight. In the year 1717 there were upwards of 2,500,000 pounds of quicksilver sent from them to Mexico, for the amalgamation of the gold and silver ores of that country.

At Guacanvelica in Brasil the annual produce of the mines, according to Bonare, amounts to one million of pounds, which are carried overland to Lima, thence to Arica, and lastly to Potosi for the same purpose.

Besides these mines there are others in Brasil near Villa Rica, where such a quantity of cinnabar and native running mercury are found near the surface of the earth, that the black slaves often collect it in good quantities, and sell it for a trifling price to the apothecaries; but none of these mines have ever been worked or taken notice of by the owners. Gold naturally amalgamated with mercury is likewise met with in the neighbourhood of that place; and it is said that almost all the gold mines of that country are worked out by simply washing them out with running water, after reducing into powder the hard ores, which are sometimes imbedded in quartzose and rocky matrices.

In the duchy of Deux Ponts and in the Lower Au-

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Idria the quicksilver flows from a schistose or stony matrix, and is probably, says Mr Kirwan, mixed with some other metal, as its globules are not perfectly spherical. The mines of Friuli are all in similar beds or strata. The metal is likewise found visibly diffused through masses of clay or very heavy stone, of a white, red, or blue colour; of which last kind are the mines of Spain, some of *Idria*, and of Sicily. Mascagni found fluid quicksilver, as well as native cinnabar and mineral ethiops, near the lake of Travale in the duchy of Sienna; but the quantity was so small as not to be worth the expence of working. On the other hand, the following mines afford profits to the owners after clearing all expences, viz. those at Kremnitz in Hungary; at Horowitz in Bohemia; Zorge in Saxony; Wolfstein, Stalberg, and Moeschfeld in the Palatinate. Mercury is also brought from Japan in the East Indies; but the greatest part of what is sold in Europe as Japan cinnabar is said to be manufactured in Holland.

Lemery, Pomet, and others, lay down some external marks by which we may distinguish those places where there are mines of quicksilver, viz. thick vapours like clouds arising in the months of April and May; the plants being much larger and greener than in other places: the trees seldom bearing flowers or fruit, and putting forth their leaves more slowly than in other places; but, according to Neumann, these marks are far from being certain. They are not met with in all places where there is quicksilver, and are observed in places where there is none. Abundance of these cloudy exhalations are met with in the Hartz forest in Germany, though no mercury has ever been found there; to which we may add, that though vast quantities of mercurial ores are found at Almaden in Spain, none of the above-mentioned indications are there to be met with.

Native mercury was formerly sought from the mines of *Idria* with great avidity by the alchemists for the purpose of making gold; and others have showed as ridiculous an attachment to the Hungarian cinnabar, supposing it to be impregnated with gold; nay, we are informed by Neumann, that not only the cinnabar, antimony, and copper of Hungary, but even the vine trees of that country were thought to be impregnated with the precious metal. Not many years ago a French chemist advertised that he had obtained a considerable quantity of gold from the ashes of vine twigs and stems, as well as of the garden soil where they grew; but the falsehood of these assertions was demonstrated by the count de Lauragais to the satisfaction of the Royal Academy of Sciences.

The reduction of mercury into a solid state, so that it might be employed like silver, was another favourite alchemical pursuit. But all processes and operations of this kind, says Neumann, if they have mercury in them, are no other than hard amalgams. When melted lead or tin are just becoming consistent after fusion, if a stick be thrust into the metal, and the hole filled with quicksilver, as soon as the whole is cold, the mercury is found solid. Macquer informs us, that mercury becomes equally solid by being exposed to the fumes of lead. Maurice Hoffman, as quoted by Neumann, even gives a process for reducing mercury, thus coagulated, to a state of malleability, viz. by repeatedly melting and quenching it in linseed oil. Thus, he

tells us, we obtain a metal which can be formed into rings and other utensils. But here the mercury is entirely dissipated by the repeated fusions, and nothing but the original lead is left. Wallerius, after mentioning strong soap-leys, or caustic lixivium, and some other liquors proper for fixing quicksilver, tells us, that by means of a certain gradatory water, the composition of which he learned from Creuling *de Aureo Vellere*, he could make a coagulum of mercury whenever he pleased, of such consistency that great part of it would resist cupellation; but what this gradatory water was, he has not thought proper to lay before the public.

2. Native precipitate *per se*, in which the metal is mineralized by aerial acid. This was lately found in *Idria*, in hard compact masses of a brownish red colour and granular texture, mixed with some globules of native mercury. An hundred parts of it afford 91 of running mercury.

Various little globules of mercury were contained in this ore, which are rendered very visible by being heated, but are soon reabsorbed by cooling. On exposing it to the fire in an iron spoon, the red colour soon became more vivid, but turned yellowish on cooling. Distilled in a pneumatic apparatus, a quantity of dephlogisticated air was produced, though less by one fourth than what should have been produced by an equal quantity of cinnabar. On distilling an ounce of this ore in a glass retort, a little yellow powder was left, which weighed a fourth part of a grain, and stained the bottom of the retort in a manner similar to what is done by the calx of silver to white glass in similar circumstances. On cupelling this powder with 144 grains of lead wrapped up in paper, the increased weight of the lead over that of the test of comparison showed that the calx was reduced into its metallic state of silver and mixed with that of lead.

3. Mineralised by the vitriolic and marine acids. This kind of ore was first discovered in the year 1776, at Obermoschal in the duchy of Deux Ponts. It has a spar-like appearance, and is either bright and white, or yellow or black, and mixed with cinnabar in a stony matrix. The native marine salt of mercury is in the state of corrosive sublimate.

4. Native cinnabar, in which the metal is mineralised by sulphur. This is of different shades from a yellowish to a deep red; and is found either pure in hard friable masses, either shapeless or crystallized in cubes, and sometimes transparent, or intermixed with clay or stone, or interspersed through the ores of other metals, particularly those of silver, copper, or martial pyrites. Its texture is either radiated, striated, scaly, or granular. An hundred parts of cinnabar contain about 80 of mercury and 20 of sulphur; but artificial cinnabar contains a little more sulphur, and hence its colour is darker. Its specific gravity is about 7.000; it sublimes in close vessels, and is decomposed and volatilized in open ones. It is found in the duchy of Deux Ponts, in the Palatinate, in Hungary, Friuli, and Almaden in Spain, and in South America, especially at Guancavelica in Peru. It is sometimes compact, and sometimes found in transparent, ruby-coloured crystals, and often in a kind of scales or flattened laminæ. It is called native vermilion, and cinnabar in flowers, when it is in the form of a very bright red powder. It is also found in different earths, in scum mixed with iron, with pyrites,

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and with sulphur. Mr Fourcroy enumerates the following varieties: 1. Transparent cinnabar, red and crystallized in very short triangular prisms, terminated by triangular pyramids. 2. Transparent red cinnabar, in octohedral crystals, consisting of two triangular pyramids united at their bases and truncated. 3. Solid compact cinnabar, of a brown or bright red; it is sometimes foliated. 4. Red cinnabar distributed in striae, on a stony matrix, or on solid cinnabar. It is sometimes composed of needles like cobalt. 5. Cinnabar in flowers, or native vermilion. It is of a bright red colour, and satin appearance, adhering to different matrices, in form of a very fine powder. It is sometimes crystallized in very small needles, and then greatly resembles the foregoing.

The finer coloured ores of mercury are never worked for extracting the metal, but used entirely as pigments; but they have been very injudiciously preferred for medicinal uses to the more pure factitious cinnabars; for we seldom meet with any native cinnabar that has not some earthy or stony matter intermixed with it, nor with two pieces that perfectly agree. There are three varieties principally distinguished in the shops; viz. 1. Cinnabar in masses weighing from one to six ounces or more. 2. In grains, prepared by breaking the worse coloured masses, and picking out the best coloured bits. 3. Washed cinnabar, prepared by washing over the lighter impurities that are to be found in it. No native cinnabar should ever be employed in medicine without being previously purified by sublimation. Neumann informs us that he never met with any native cinnabar which did not leave a grey ash or sand, amounting, among different parcels, from one ninth to one fifth of the mineral employed. The residuum had no gold in it, though the colour of its solution and precipitate gave some expectation of it at first sight.

Neumann remarks, that though vitriolic acid forms with mercury a lively yellow concrete, viz. turbith mineral, and with the inflammable principle a yellow sulphur; and though sulphur itself forms with mercury a beautiful red cinnabar; yet the same vitriolic acid destroys the red colour entirely, rendering it as white as milk. This change is not immediately produced on common cinnabar by the vitriolic acid; but, on being digested over a strong sand heat in a glass cup, it soon becomes as white as cream; and the vitriolic acid takes the form of a strong sulphureous and volatile vapour, very suffocating and corrosive; emitting very piercing fumes for some time, which turned the paper that covered it black, and destroyed its texture.

5. Black ore of mercury, in which the metal is mineralized by sulphur and copper. This is of a blackish grey colour, a glassy texture, brittle, heavy, and decrepitating strongly when heated. It is found at Mueschel Lansberg. An ore of this kind is also found in the duchy of Deux Ponts. In the sulphur of Idria a black cinnabar is likewise said to be found, which retains its colour in sublimation; but this is not yet sufficiently confirmed, though it is too bold an assertion of Dr J. R. Forster that no such cinnabar has ever been found. He adds, that a certain learned man thought he had discovered some near the copper ores at Lauterberg; but that it proved to be a red copper calx, which is still to be met with in that place.

6. Pyritous mercurial ore was brought from Dayphiny by Mr Montigny in 1768. It is grey, whitish, and friable. An hundred parts yielded one of mercury, one half of silver, the remainder being iron, cobalt, sulphur, and arsenic.

7. An ore of mercury, in which the metal is mineralized with iron by sulphur, is mentioned by Sir Torbern Bergman in his *Sciagraphia*, sect. 177. He says that it is doubtful whether this does not belong to the species of cinnabar, as the iron is perhaps only mechanically diffused thereon. Mr Mongez informs us, that there are but few instances of cinnabar in which iron is not found in its calcined form, though, in the act of the ore being reduced, it passes to its metallic state, and becomes capable of being acted upon by the loadstone.

Another pyritous ore of cinnabar was found at Menidot, near St Lo in Lower Normandy. It consisted of differently sized grains of a red brown colour: they had a vitriolic taste and sulphureous smell. Pyritous ores of this kind are likewise found at Almaden in Spain, and at Stahlberg in the Palatinate. The cinnabarie pyrites of this last place are of a dodecaedral form.

8. Mr Gellert informs us, that an ore of quicksilver is met with in Idria, where the mercury lies in an earth or stone, as if it were in a dead form; and has the appearance of a red-brown iron-stone, but much heavier. It contains from three quarters to seven-eighths of the purest mercury, leaving after distillation a very black strong earth, giving also some marks of cinnabar. For, as we do not know the ultimate divisibility of mercury, we cannot justly determine the point of its fluidity, although its globules may be no more discernible.

The *liver-ore*, which is most common in Idria, and has its name from its colour, resembles an indurated iron-clay; but its weight discovers it to have metallic contents. An hundred weight of it sometimes yields 80 pounds of quicksilver.

The *brand-erz*, or burning ore of the Germans, likewise belongs to this species. It may be lighted at a candle, and yields from 9 to 50 pounds of metal in the 100.

9. Dr Gmelin informs us, that cinnabar mixed with arsenic or realgar is said to be found in Japan; and that at Morsfield the cinnabar and white calx of arsenic present themselves in the same rock.

10. Besides the ores already mentioned, we sometimes meet with quicksilver natively amalgamated with gold, silver, and other metals. This is taken notice of by Bergman; and from the authorities of Monet and Prof. Gmelin, Mr Kirwan informs us, that in Sweden and Germany this metal has been found united to silver in an hard and brittle amalgam. M. de L'Isle had a specimen of this ore from Germany; which, as M. Mongez informs us, is imbedded in a quartzose mass, and mixed with cinnabar. A specimen brought from the mine called *Carolina*, in a crystalline form, was deposited in the royal cabinet at the king's garden at Paris. M. de L'Isle likewise informs us, that a specimen of native gold was brought from Hungary, which, according to Croustedt, was probably an amalgam of mercury and gold. It is composed of quadrangular prisms, of a greyish yellow colour, and brittle texture. Neumann likewise observes, that sometimes a mineral, containing

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containing gold or silver, is met with among mercurial ores, though very rarely.

These natural amalgams account for the great specific gravity of some kinds of quicksilver. This may proceed from a natural mixture of gold, though, according to Boerhaave, it may also arise from its being redistilled a great number of times. By a similar mode of reasoning we may conclude, that the smallest specific gravities of quicksilver proceed from its amalgamation with silver, lead, and other metals or semimetals, which in spite of repeated distillations may still preserve their union with it; for Dr Boerhaave informs us that he could not, by any number of distillations, free mercury perfectly either from tin or lead.

M. Magellan, in his notes on Cronstedt's Mineralogy, says, "That mercury is many times found amalgamated with lead, is easily evinced by the process of M. Grosse mentioned by Macquer in his elements of Chemistry, where the method of extracting mercury from some solutions of lead is described; but the same Macquer, in his Chemical Dictionary, positively affirms, that, though Beecher and Kunckel have both given other processes for extracting mercury from lead, and though the method pointed out by M. Grosse is easier than the others, nevertheless it does not succeed if the lead be quite pure without any amalgamation with mercury. And Boerhaave has expressly made the same assertion, complaining of those authors who affirm the contrary." Dr Black, however, seems to be of a different opinion; and, in his public course of lectures, teaches that, "by some processes of the more difficult kind, mercury may be extracted from lead;" though he cautions us, at the same time, not to infer from this, or any other chemical process, the possibility of the transmutation of metals.

Mercury is not in any way altered by the action of light. Its dilatation by heat is extremely regular, as has lately been shown, in a very great variety of experiments, by Dr Adair Crawford; for which reason it is used as the measure of heat, and thermometers are usually filled with this metal. When opposed to the heat of about 600° of Fahrenheit, it boils and is dispersed in an invisible fume; which, however, has been observed to have the elasticity of the steam of water, and to burst an iron box in which it was attempted to confine it. If it be made to boil in a close vessel fitted with a proper apparatus, it will all come over in its proper form, and leave any fixed matter it might contain in the retort. This affords an easy method of purifying it from the base metals with which it is frequently adulterated; though even in this way it is necessary to raise the fire cautiously, or a part of the fixed metal will be carried up along with the mercury. And even with all the care that can be taken, it has been found impossible, as has been already said, to free it perfectly from a mixture of the base metals by any number of distillations.

By a very great number of distillations, however, it was said that some change might be made upon this metal; and that it became not only purer, but specifically heavier, by such an operation. Boerhaave, after making it undergo this operation 511 times, found some difference; but three years after, in a Memoir inserted in the Philosophical Transactions for 1736, he acknowledged, that, on repeating the operation 877 times, its

specific gravity, as shown by Dr Gravefande's nice hydrostatic balance, appeared to be no more than 13.500 to distilled water.

"Boerhaave died (says Mr Magellan in his Notes on Cronstedt's Mineralogy) two years after, on the 23d of September 1738; and left his papers to his two nephews, Herman, who died the 7th of October 1753, and Kaw, who died five years after. On their deaths the manuscripts fell into the hands of Charles Frederick Kruse physician to the Emperor of Russia. This gentleman published a short extract from Boerhaave's Diary in the ninth volume of the *Novi Commentarii* of the Imperial Academy of Petersburg, of which the following are the results.

"The specific gravity of the purest gold to that of distilled water is	19,024
That of mercury distilled once in a retort	13,570
Distilled 1009 times	13,590
Once from its amalgam with gold	13,550
750 times from the same amalgam	13,520
877 times from the same	13,500
Once from its amalgam with silver	13,550
217 times from the same amalgam	13,500

"It is evident, therefore, by these facts, that mercury does not acquire any additional increase to its specific gravity by the mere repetition of simple distillations, nor by its amalgamations with gold or silver, provided it be afterwards properly separated by fire."

It is certain, however, that there are very considerable differences in the specific gravity of different specimens of quicksilver; and authors have by no means agreed in fixing the standard.—Bergman states it at 14.110; and Muschenbroek asserts that such was the specific gravity of Boerhaave's quicksilver that had been distilled 511 times; but some modern authors, among whom is M. Fourcroy, state the specific gravity of this metal at no more than 13.000. Modern experiments, however, show that it is generally about 13.500 or 13.600. "This (says Mr Magellan) I am informed was the mean specific gravity found by the late Lord Cavendish, after the repeated and nice trials he made upon 50 different specimens of quicksilver, on which he employed all his industry and attention to determine this point.

"The hydrostatical experiments I lately undertook of this kind upon ten different specimens of mercury, two of which were revived from natural and artificial cinnabar by the operator of Mr Kirwan, confirmed me in the same opinion.

"The temperature of the atmosphere was nearly the mean, viz. at the 50th degree of Fahrenheit's thermometer; and the scales employed were so nice, that they turned with the hundredth part of a grain when loaded with four pounds weight.—The method made use of to ascertain these specific gravities is the easiest of all. A phial of white glass with a ground stopple was counterbalanced with lead or other matter in a nice pair of scales. The substance to be tried was introduced into the phial and weighed together, and the weight we suppose = *a*. The remaining space of the phial being then filled with distilled water, we suppose the weight now to be = *b*. Lastly, the phial was filled with distilled water, and the weight supposed = *c*. It is evident,

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dent, that $b - a = d$, the quantity of water in the second operation; $c - d = e$, the water whose bulk is equal to that of the substance; and that $\frac{a}{e}$ is the specific gravity sought for.—Particular care was taken that no bubble of air remained in the inside. For this purpose a very small groove was made with a file on the inside of the glass stopper; and this was introduced sidewise without admitting any air, leaving the superfluous water to rush out.

“The greatest specific gravity of any of those specimens was 13.620, and the least 13.450. The heaviest was neither of the two that had been distilled from cinabar, but a common quicksilver bought at Apothecaries Hall, London; and the lightest was taken from a barometer of the best and dearest kind made by one of the most reputed instrument-makers in England.

“The most obvious cause of this difference of specific gravity in quicksilver seems to be its mixture or amalgamation with other metals. Certainly, when united to gold, its gravity must of course be specifically augmented: on the contrary, it must be lessened when united with any other metal, platina only excepted; and the same must be the case whether water or any other moisture is mixed with it; for in such a case the metal will be found heavier after evaporation. A simple boiling of the quicksilver over the fire in an open vessel will completely free it from this mixture; and no careful maker of experiments should neglect the preparation before he undertakes to employ mercury in any process, or for any purpose of the philosophic kind. The boiling must be continued for 20 or 30 minutes in order to expel the whole moisture.

Another cause by which the specific gravity of quicksilver becomes subject to alteration is the difference of temperature of the atmosphere at the time of making the experiment. Nor is it quicksilver alone, but every other substance whose specific gravity is affected by this cause in a greater or lesser degree; inasmuch that Mr Magellan does not hesitate to pronounce the labours of all those who have undertaken to compose tables of specific gravities, without regard to this circumstance, to be, if not entirely useless, at least incapable of affording proper satisfaction in the nice inquiries that depend on this knowledge.

In Eisechmid's table of specific gravities it is asserted, that a cubic inch of mercury in summer weighs seven ounces, one gros, 66 grains; but in winter it weighs 20 grains more: the whole weight then being seven ounces, two gros, 14 grains (allowing 72 grains to the gros). This, however, leaves the matter almost in as great uncertainty as before; the summer and winter temperature being widely different in different places, and very often even in the same place. Unless therefore the temperature of the air is attended to at every experiment in taking the specific gravity of any substance whatever, there can be no certainty of the result.

Quicksilver always feels cold when touched in the common temperature of the atmosphere. Our sensations, according to Fourcroy, deceive us in this case, for a thermometer dipped in quicksilver always shows the common temperature. “The great continuity of contact between the live skin and numerous metallic particles in an equal space, and which are proportional to its great specific gravity, necessarily produces a strong-

er sensation of its own temperature, this being always much less than that of a living body; and the multiplicity of these points of contact being all at once applied to this organ of sensation, must be more powerfully felt than whenever we touch any other matter that is lighter in itself, or of a less density.”

Notwithstanding this apparent coldness, however, quicksilver, when exposed to the same degree of heat, and in the same circumstances with various other substances, soon becomes hotter to the touch than any of them. “The fundamental principle of this (says Mr Magellan) consists in the small quantity of specific fire, or the less capacity which mercury is endowed with of receiving heat. This is such, that, compared with the capacity of water for the same purpose, it is in the ratio of 0.033 to 100, as appears by the table of the quantities of specific fire contained in various bodies.—This table, published in Magellan's Essay on Elementary Fire, was grounded upon various important experiments and observations made by Mr Kirwan, in consequence of the new Theory of Fire discovered by Dr Crawford. Hence it follows, that if equal quantities of heat be communicated to equal quantities of water and mercury, the latter will have a temperature 30 times greater than that of the water; that is to say, in the inverse ratio of their respective capacities, or as 1 to 30 ($= 0.033 : 1.000$), in the same manner as it must happen, when equal measures of corn or of any fluid are thrown into vessels whose bottoms are as 30 to 1; for then their heights must necessarily be in their inverse ratio, viz. of 1 to 30, &c. See CHEMISTRY, n° 1225, &c.

Quicksilver does not appear to dissolve in water; but Fourcroy remarks, that physicians are in the practice of suspending a bag full of it in vermifuge ptisans during their ebullition, and that experience has evinced the good effects of it. Lemery asserts, that in this process there is no loss of weight; but this is denied by others. Fourcroy asserts, that this metal, rubbed between the fingers, emits a perceptible odour, though Magellan says he tried the experiment many times without success.

Fourcroy likewise asserts, that mercury when pure emits a phosphoric light by agitation, particularly in hot seasons. This phenomenon has certainly been observed in the mercury of the barometer; but its appearance on other occasions rests entirely on the authority of Mr Fourcroy. Even in the barometer it does not take place, unless the Torricellian vacuum be not perfectly made in the space at the top of the tube. Phials of glass nearly exhausted of air, and containing some quicksilver hermetically sealed up, will, on being shaken, produce as much light in the dark as is sufficient to show the hour on the dial-plate of a watch. But if a perfect vacuum be produced by nicely boiling the quicksilver within the glass, no appearance of this kind is to be perceived. The phenomenon is certainly of the electrical kind; and its not appearing in the perfect vacuum is owing to the difficulty there is in setting in motion any large quantity of electric matter by itself, which indeed can scarce be done without producing very violent effects. See ELECTRICITY-Index.

Mercury unites with all the metals and semimetals, excepting iron and regulus of antimony. These compounds are called *amalgams*; and Mr Machy has observed,

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served, that in forming them a certain degree of cold is produced. He made the experiment by covering the ball of a thermometer with tin-foil, and then dipping it into quicksilver; upon which that in the thermometer fell some degrees: which agrees perfectly well with the doctrine of latent heat first discovered by Dr Black, as it shows that in this, as well as other cases, where a body passes from a solid into a fluid state, a degree of cold is produced.—The following observations on the amalgams of mercury with different metals are extracted from the Memoirs of the Academicians of Dijon.

1. The amalgam of gold and mercury crystallizes into quadrangular pyramids. Six ounces of mercury are retained by one of gold in this crystallization; but that with silver retains a third part more of quicksilver.

2. The amalgam with silver is likewise susceptible of crystallization, and assumes the form of a tree; every ounce of silver retaining eight of mercury. This amalgam, by means of the nitrous acid, well freed from the vitriolic by solution of silver in the same, forms that curious kind of vegetation mentioned in the article CHEMISTRY, n° 754, called *Arbor Diana*, or *Arbor Philosophorum*.—The following is recommended by Mr Magellan as the shortest process:

“ Dissolve 228 grains of silver, and half as much quicksilver, in pure nitrous acid. Add to the solution, when made, five ounces (of 576 grains each) of distilled water. Put this solution into a spherical vessel of white glass, at the bottom of which must already be put 432 grains of an amalgam of silver of the consistence of butter: let the vessel be kept in a quiet place, free from any shaking or external agitation; and at the end of some few hours the figure of a bush or tree of silver will be formed within the water of the glass vessel. The metals contained in the solution and in the amalgam attract each other, and a number of small tetrahedral crystals are formed, which lay hold at one another's end, and form the appearance of a vegetation.

3. Copper is amalgamated with mercury with great difficulty, and only by mixing blue vitriol with mercury and water in an iron retort over the fire. The acid then attacks the vessel, and the copper is precipitated in a metallic state, which, by stirring it with an hot iron spatula, unites to the mercury, but does not crystallize.

4. Two ounces of melted lead poured on a pound of mercury produce a half-fluid amalgam, which being decanted gives some crystals like those of silver. One ounce of these crystals retains an ounce and an half of mercury.

5. The amalgam of tin crystallizes into thin shining lamellæ, with polygonous cavities between one another. Two ounces of tin retain six of mercury in this crystallization.

6. Mercury amalgamates with bismuth by means of heat, and produces crystals of an octohedral form, and lamellated triangles and hexagons. They are black on the upper surface, and shining underneath. In this crystallization the bismuth retains double its weight of mercury.

7. Zinc, in fusion, poured upon mercury, produces a crackling noise resembling that produced by a hot body thrown into boiling water. It crystallizes very well into lamellated hexagonal figures, leaving cavities among themselves. One ounce of zinc retains two and an half of mercury in this crystallization.

8. *Quicksilver* does not amalgamate with arsenic, except by heat, and then only in very small quantity. This metal answers very important purposes both in medicine and the arts. Though it has no perceptible taste, it produces very remarkable effects on the stomach and intestines of animals, as well as on the surface of the skin. Insects and worms are extremely sensible of this effect, and the metal, almost in any state, is exceedingly pernicious to them. Physicians, therefore, employ it as an excellent vermifuge (see MEDICINE, p. 341.), and it is likewise one of the most powerful remedies in the materia medica for many obstinate disorders besides those of the venereal kind, in which its efficacy has long been celebrated. “ Even the most virulent product of mercury (says Mr Magellan), known by the name of sublimate corrosive, which is the most violent poison, is often taken internally in very minute doses, under the direction of skilful physicians, and produces the most happy effects in a great variety of cases even of the most desperate kind. This is a fact which I have experienced myself, in a dreadful scorbutic complaint which I suffered for above four years, with restless and violent pains in the eyes and head. None of the most able physicians in London and Paris I consulted afforded me any effectual relief, till I had the good fortune to consult Mr Sacre surgeon-oculist at Antwerp. His prescription consisted of three grains of sublimate dissolved in a pint of common proof spirit. The dose consisted in taking every morning two spoonfuls of it in a pint of new milk. In less than two months I began to feel relief; and in three months time was completely cured. The first methodical practice of this remedy was communicated to the celebrated Van Swieten, first physician to the Emperor's court, by the late Dr A. R. Sanches, then chief physician to the court of Petersburg, as appears by the last volume of the Commentaries of the same Van Swieten, published in 1772. This volume was published after the author's death; but he had enjoyed during his life the glory of being the author of this wonderful remedy, which continues to bear his name among the ignorant and inaccurate physicians of our times.”

But whatever uses this salt may be put to when taken in small quantities, it is certainly not less violent than arsenic itself, if taken in a large dose; and the danger is the greater, on account of the difficult solution of the salt, which requires for this purpose 19 times its weight of water. Alkaline salts, however, prove a very effectual antidote, and will instantly relieve the symptoms; but, on account of the insolubility of the poisonous salt, the disorders occasioned by it soon return, and require a repetition of the same remedy. In cases where alkaline salts are not immediately at hand, soap dissolved in water will answer the same purpose; or if this also should not be instantly procurable, chalk, lime, spirit of hartshorn, or magnesia alba, might be used with good effect.

Quicksilver is employed in Chili and Peru to extract gold and silver, when native, from the earthy matters with which they are mixed. The principle on which this method is founded is the strong mutual attraction betwixt mercury and the precious metals. By reason of this the smallest particles either of gold or silver form an amalgam with the mercury, part of which is strained off, and the remainder either separated by distillation

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match.

distillation in iron retorts, or by a kind of distillation *per descensum*; putting it in a kind of metallic sieve over a vessel of water, to receive the mercury, which is driven down by a fire lighted in a vessel above the amalgam.

The amalgam with gold serves also to gild copper or silver, so that they appear as if made of solid gold.—For this purpose the pieces are to be well cleaned, and then dipped in a weak aquafortis; then in a nitrous solution of quicksilver, which covers them with a kind of silvery. After this the amalgam of gold is very equally spread over them; which being done, the piece is exposed to a heat sufficient to volatilize the quicksilver, and the gold is then left strongly adhering to the metal. The only use to which the amalgam of mercury with lead has hitherto been applied, is the luting glass vessels in which specimens of natural history are to be preserved in spirit of wine. For this it is more proper than any other substance, having an excellent effect in preventing evaporation. The amalgam of tin is commonly employed in making looking-glasses or mirrors. The thin sheet of tin is laid down on a large flat table of stone; a proper quantity of mercury, in which some tin has already been dissolved to prevent it from destroying the tin sheet, is rubbed over with a bunch of cloth like a flat bung, and the glass carefully slid upon it from one end to the other, in such a manner that the dirty crust of the quicksilver is driven off before its edge; and the glass is then loaded with weights all over: by inclining gradually the stone table, the superfluous mercury is discharged; and in a few hours both cohere together. This amalgam is used for exciting the electricity of glass globes in the common electrical machines, but is said to be inferior in strength to that made with zinc.

Quicksilver heated by itself, with access of air, is by degrees converted into a red powder, improperly called *Mercurius precipitatus per se*. It consists of the calx of the metal united with the basis of dephlogisticated or pure air, which may be expelled from it again by a strong heat; and this was the first method by which Dr Priestley obtained this kind of air.

Mercury is not altered by the contact of air: It is only observed, that it becomes tarnished by the particles of dust which the air deposits; and from that circumstance mercury has been called the loadstone of dust.—Though all bodies have this property, it seems more remarkable in mercury than any other, on account of its great splendour; but it is not in the least changed by this circumstance, nothing more being necessary to restore it to its original brilliancy than filtration through a piece of shamoy leather.

The volatility of mercury prevents it from uniting with earths in the way of fusion; though M. Fourcroy is of opinion that its red calx, or precipitate *per se*, might perhaps fix in glasses, and colour them, as is observed in the calx of arsenic.

QUICK-MATCH, among artillery men, a kind of combustible preparation formed of three cotton strands drawn into length, and dipped in a boiling composition of white-wine vinegar, saltpetre, and mealed powder. After this immersion it is taken out hot, and laid in a trough where some mealed powder, moistened with spirits of wine, is thoroughly incorporated into the twists of the cotton, by rolling it about therein. Thus prepared, they are taken out separately,

and drawn through mealed powder; then hung upon a line and dried, by which they are fit for immediate service.

QUID PRO QUO, in law, *q. d.* "what for what," denotes the giving one thing of value for another; or the mutual consideration and performance of both parties to a contract.

QUID PRO QUO, or QUI PRO QUO, is also used in physic to express a mistake in the physician's bill, where *quid* is wrote for *quo*, i. e. one thing for another; or of the apothecary in reading *quid* for *quo*, and giving the patient the wrong medicine. Hence the term is in the general extended to all blunders or mistakes committed in medicine, either in the prescription, the preparation, or application of remedies.

QUIDDITY, QUIDDITAS, a barbarous term used in the schools for *essence*. The name is derived hence, that it is by the essence of a thing that it is *tale quid*, such a *quid*, or thing, and not another. Hence what is essential to a thing is said to be *quiddative*.

QUIETISTS, a religious sect, famous towards the close of the last century. They were so called from a kind of absolute rest and inaction, which they supposed the soul to be in when arrived at that state of perfection which they called the *unitive life*; in which state they imagined the soul wholly employed in contemplating its God, to whose influence it was entirely submissive; so that he could turn and drive it where and how he would. In this state, the soul no longer needs prayers, hymns, &c. being laid, as it were, in the bosom and between the arms of its God, in whom it is in a manner swallowed up.

Molinos, a Spanish priest, is the reputed author of Quietism; though the Illuminati in Spain had certainly taught something like it before. The sentiments of Molinos were contained in a book which he published at Rome in the year 1681, under the title of the *Spiritual Guide*; for which he was cast into prison in 1685, and where he publicly renounced the errors of which he was accused. This solemn recantation, however, was followed by a sentence of perpetual imprisonment, and he died in prison in the year 1696. Molinos had numerous disciples in Italy, Spain, France, and the Netherlands. One of the principal patrons and propagators of Quietism in France was Marie Bouvieres de la Mothe Guyon, a woman of fashion, remarkable for goodness of heart and regularity of manners; but of an unsettled temper, and subject to be drawn away by the seduction of a warm and unbridled fancy. She derived all ideas of religion from the feelings of her own heart, and described its nature to others as she felt it herself. Accordingly, her religious sentiments made a great noise in the year 1687; and they were declared unsound, after accurate investigation, by several men of eminent piety and learning, and professedly confuted, in the year 1697, by the celebrated Bossuet. Hence arose a controversy of greater moment between the prelate last mentioned and Fenelon archbishop of Cambray, who seemed disposed to favour the system of Guyon, and who in 1697 published a book containing several of her tenets. Fenelon's book, by means of Bossuet, was condemned in the year 1699, by Innocent XII. and the sentence of condemnation was read by Fenelon himself at Cambray, who exhorted the people to respect and obey the papal decree.

Not-

Quid
Quidditas.

Quill.
Quill.

Notwithstanding this seeming acquiescence, the archbishop persisted to the end of his days in the sentiments, which, in obedience to the order of the pope, he retracted and condemned in a public manner.

A sect similar to this had appeared at Mount Athos in Thessaly, near the end of the 14th century, called *Hesychasts*, meaning the same with Quietists. They were a branch of the mystics, or those more perfect monks, who, by long and intense contemplation, endeavoured to arrive at a tranquillity of mind free from every degree of tumult and perturbation. In conformity to an ancient opinion of their principal doctors (who thought there was a celestial light concealed in the deepest retirements of the mind), they used to sit every day, during a certain space of time, in a solitary corner, with their eyes eagerly and immoveably fixed upon the middle regions of the belly or navel; and boasted, that while they remained in this posture, they found, in effect, a divine light beaming forth from their soul, which diffused through their hearts inexpressible sensations of pleasure and delight. To such as inquired what kind of light this was, they replied, by way of illustration, that it was the glory of God, the same celestial radiance that surrounded Christ during his transfiguration on the Mount. Barlaam, a monk of Calabria, from whom the Barlaamites derived their denomination, styled the monks who adhered to this institution *Massalians* and *Euchites*; and he gave them also the new name of *Umbilicani*. Gregory Palamas, archbishop of Thessalonica, defended their cause against Barlaam, who was condemned in a council held at Constantinople in the year 1341.—See *Fenelon's Max. des Saints*.

The Mahometans seem to be no strangers to quietism. They expound a passage in the 17th chapter of the Koran, viz. "O thou soul which art at rest, return unto thy Lord, &c." of a soul which, having, by pursuing the concatenation of natural causes, raised itself to the knowledge of that being which produced them, and exists of necessity, rests fully contented, and acquiesces in the knowledge, &c. of him, and in the contemplation of his perfection.

QUILLET (Claude), an eminent Latin poet of the 17th century, was born at Chinon, in Touraine, and practised physic there with reputation: but having declared against the pretended possession of the nuns of Loudun, in a manuscript treatise, the original of which was deposited in the library of the Sorbome, he was obliged to retire into Italy, where he became secretary to the marshal d'Estrees, the French ambassador at Rome. In 1655 Quillet having published in Holland a Latin poem, entitled *Callipædia*, under the name of *Galvidius Latus*, he there inserted some verses against the cardinal Mazarine and his family; but that cardinal making him some gentle reproaches, he retrenched what related to the cardinal in another edition, and dedicated it to him, Mazarine having, before it was printed, given him an abbey. He died in 1661, aged 59, after having given Menage all his writings, and 500 crowns to pay the expence of printing them; but the abbé took the money and papers, and published none of them. His *Callipædia*, or the art of getting beautiful children, has been translated into English verse.

QUILLS, the large feathers taken out of the end

of the wing of a goose, crow, &c. They are denominated from the order in which they are fixed in the wing; the second and third quills being the best for writing, as they have the largest and roundest barrels. Crow-quills are chiefly used for drawing. In order to harden a quill that is soft, thrust the barrel into hot ashes, stirring it till it is soft, and then taking it out, press it almost flat upon your knee with the back of a penknife, and afterwards reduce it to a roundness with your fingers. If you have a number to harden, set water and alum over the fire, and while it is boiling put in a handful of quills, the barrels only, for a minute, and then lay them by.

QUIN (James), a celebrated performer on the English stage, was born at London in 1693. He was intended for the bar; but preferring Shakespear to the statutes at large, he on the death of his father, when it was necessary for him to do something for himself, appeared on the stage at Drury-lane. In 1720, he first displayed his comic powers in the character of Falstaff, and soon after appeared to as great advantage in Sir John Brute; but it was upon Booth's quitting the stage that Quin appeared to full advantage, in the part of Cato. He continued a favourite performer until the year 1748, when, on some disgust between him and Mr Rich the manager, he retired to Bath, and only came up annually to act for the benefit of his friend Ryan; until the loss of two front teeth spoiled his utterance for the stage. While Mr Quin continued upon the stage, he constantly kept company with the greatest geniuses of the age. He was well known to Pope and Swift; and the earl of Chesterfield frequently invited him to his table; but there was none for whom he entertained a higher esteem than for the ingenious Mr Thomson, to whom he made himself known by an act of generosity that does the greatest honour to his character; and for an account of which see our life of THOMSON. Mr Quin's judgment in the English language recommended him to his royal highness Frederick prince of Wales, who appointed him to instruct his children in speaking and reading with a graceful propriety; and Quin being informed of the elegant manner in which his present majesty delivered his first gracious speech from the throne, he cried out in a kind of ecstasy, "Ay—I taught the boy to speak!" Nor did his majesty forget his old tutor; for, soon after his accession to the throne, he gave orders, without any application being made to him, that a genteel pension should be paid to Mr Quin during his life. Mr Quin, indeed, was not in absolute need of this royal benefaction; for as he was never married, and had none but distant relations, he sunk 2000 l. which was half his fortune, in an annuity, for which he obtained 200 l. a-year; and with about 2000 l. more in the funds, lived in a decent manner during the latter part of his life at Bath, from whence he carried on a regular correspondence with Mr Garrick, and generally paid a visit to his friends in the metropolis once a year, when he constantly passed a week or two at Mr Garrick's villa at Hampton. He died of a fever in 1766.

QUINARIUS, was a small Roman coin equal to half the denarius, and consequently worth about three pence three farthings of our money. See MONEY.

Quin.
Quinar. us.

Quinaut
||
Quinque-
renis.

It was called *quinarius*, because it contained the value of five asses, in the same manner as the denarius was named from its containing ten.

QUINAUT (Philip), a celebrated French poet, born of a good family at Paris in 1635. He cultivated poetry from his infancy, and 16 dramatic pieces of his were acted between the year 1653 and 1666. In the mean time, Quinaut was not so much devoted to poetry but that he applied himself to the study of the law; and made his fortune by marrying the widow of a rich merchant to whom he had been useful in his profession. Quinaut afterwards turned his attention to the composing of operas, which were set to music by the famous Lully; and Lully was charmed with a poet whose verses were not too nervous to yield to the capricious airs of music. He died in 1688, after having enjoyed a handsome pension from Louis XIV. for many years: and we are told he was extremely penitent in his last illness for all those of his compositions which tended to inspire love and pleasure.

QUINCE, in botany. See **CYDONIA**.

QUINCUNX, in Roman antiquity, denotes any thing that consists of five-twelfths of another; but particularly of the ar.

QUINCUNX Order, in gardening, is a plantation of trees, disposed originally in a square consisting of five trees, one at each corner, and a fifth in the middle; which disposition, repeated again and again, forms a regular grove, wood, or wilderness.

QUINDECAGON, in geometry, a plain figure with 15 sides and 15 angles.

QUINDECENVIRI, in Roman antiquity, a college of 15 magistrates, whose business it was to preside over the sacrifices. They were also the interpreters of the Sybil's books; which, however, they never consulted but by an express order of the senate.

QUINQUAGENARIUS, in Roman antiquity, an officer who had the command of 50 men.

QUINQUAGESIMA SUNDAY, Shrove Sunday, so called as being about the 50th day before Easter.

QUINQUATRIA, or **QUINQUATRUS**, was a festival kept at Rome in honour of Minerva, which began on the 18th of March, or as others will have it on the 19th, and lasted five days. On the first day they offered sacrifices and oblations without the effusion of blood; the second, third, and fourth, were spent in shows of gladiators; and on the fifth day they went in procession through the city. Scholars had a vacation during the solemnity, and presented their masters at this time with a gift or fee, called *Minerval*. Boys and girls used now to pray to the goddess Minerva for wisdom and learning, of which she had the patronage. Plays were acted, and disputations held, at this feast, on subjects of polite literature. The quinquatria were so called, because they lasted for five days. There seems to be a strong resemblance betwixt this festival and the panathenæa of the Greeks.

QUINQUENNALIS, in Roman antiquity, a magistrate in the colonies and municipal cities of that empire, who had much the same office as the ædile at Rome.

QUINQUEREMIS, in the naval architecture of the ancients, a name given to a galley which had five rows of oars. They divided their vessels in general into *menocrota* and *polycrota**. The former had only one tire

of rowers: the latter had several tires of them, from two or three up to 20, 30, or even 40; for such a vessel we have an account of in the time of Philopater, which required no less than 4000 men to row it.

Meibom has taken off from the imaginary improbability of there ever having been such a vessel, by reducing the enormous height supposed necessary for such a number of rows of oars and men to work them, by finding a better way of placing the men than others had thought of. The quinquereemes of the ancients had 420 men in each; 300 of which were rowers, and the rest soldiers. The Roman fleet at Messina consisted of 330 of these ships; and the Carthaginian, at Lilybæum, of 350 of the same size. Each vessel was 150 feet long. Thus 130,000 men were contained in the one, and 150,000 in the other, with the apparatus and provisions necessary for such expeditions as they were intended for. This gives so grand an idea of the ancient naval armaments, that some have questioned the truth of the history: but we find it related by Polybius, an historian too authentic to be questioned, and who expresses his wonder at it while he relates it.

QUINQUEVIRI, in Roman antiquity, an order of five priests, peculiarly appointed for the sacrifices to the dead, or celebrating the rites of Erebus.

QUINQUINA. See **CINCHONA**.

QUINSY, or **QUINZY**. See **MEDICINE**, n° 177—183.

QUINTEN, a town of France, in Bretagne, with the title of a duchy, and a handsome castle. It is seated in a valley near the river Guy, and near a large forest of the same name, eight miles south of St Brieux, and 200 west of Paris. W. Long. 2. 40. N. Lat. 48. 26.

QUINTESSENCE, in chemistry, a preparation consisting of the essential oil of some vegetable substance, mixed and incorporated with spirit of wine.

QUINTESSENCE, in alchemy, is a mysterious term, signifying the fifth or last and highest essence of power in a natural body.

QUINTILE, in astronomy, an aspect of the planets when they are 72 degrees distant from one another, or a fifth part of the zodiac.

QUINTILIANUS (Marcus Fabius), a celebrated Latin orator, and the most judicious critic of his time, was a native of Calagurris, or Calahorra, in Spain; and was the disciple of Domitius Afer, who died in the year 59. He taught rhetoric at Rome for 20 years with great applause: and not only laid down rules for speaking, but exhibited his eloquence at the bar. Some authors imagine, but with little foundation, that he arrived to the consularship; but it is more certain that he was preceptor to the grandsons of the emperor Domitian's sister. There is still extant his excellent work, intitled, *Institutiones Oratorie*, which is a treatise of rhetoric in 12 books; where his precepts, judgment, and taste, are justly admired. These institutions were found entire by Poggius, in an old tower of the abbey of St Gal, and not in a grocer's shop in Germany as some authors have imagined. There is also attributed to Quintilian a dialogue *De causis corruptæ eloquentiæ*; but it is more commonly ascribed to Tacitus. The best editions of Quintilian's works are those of Mr Obrecht, published at Strasburg in 2 vols 4to, in 1698, and of M. Capperonier, in folio. There is an English translation by Mr Guthrie.

Quinque-
viri
||
Quintilia-
nus.

* See *Polycrota*.

Quintilians
||
Quintus.

Quintilian had a son of the same name, on whom he bestows great praises. This son ought not to be confounded with Quintilian the father, or rather the grandfather, of him who is the subject of this article, and who wrote 145 declamations. Ugolin of Parma published the first 136 in the 15th century; the nine others were published in 1563 by Peter Ayrault, and afterwards by Peter Pithou in 1580. There have also been 19 other declamations printed under the name of Quintilian the Orator; but, in the opinion of Vossius, they were written neither by that orator nor his grandfather.

QUINTILIANS, a sect of ancient heretics, thus called from their prophets Quintilia. In this sect the women were admitted to perform the sacerdotal and episcopal functions. They attributed extraordinary gifts to Eve for having first eaten of the tree of knowledge; told great things of Mary the sister of Moses, as having been a prophetess, &c. They added, that Philip the deacon had four daughters, who were all prophetesses, and were of their sect. In these assemblies it was usual to see the virgins entering in white robes, personating prophetesses.

QUINTIN MATSYS, also called the *Farrier of Antwerp*, famous for being transformed, by the force of love, from a blacksmith to a painter. He had followed the trade of a blacksmith and farrier near twenty years; when falling in love with a painter's daughter who was very handsome, and disliked nothing but his trade, he quitted it, and betook himself to painting, in which he made a very uncommon progress. He was a diligent and careful imitator of ordinary life, and succeeded better in representing the defects than the beauties of nature. Some historical performances of this master deserve commendation, particularly a Descent from the Cross, in the Cathedral at Antwerp: but his best known picture is that of the two Misers in the gallery at Windsor. He died in 1529.

QUINTINIE (John de la), a celebrated French gardener, born at Poitiers in 1626. He was brought up to the law; and acquitted himself so well at the bar as to acquire the esteem of the chief magistrate. M. Tamboneau, president of the chamber of accounts, engaged him to undertake the preceptorship of his only son, which Quintinie executed entirely to his satisfaction; applying his leisure hours to the study of writers on agriculture, ancient and modern, to which he had a strong inclination. He gained new lights by attending his pupil to Italy; for all the gardens about Rome being open to him, he failed not to add practice to his theory. On his return to Paris, M. Tamboneau gave up the management of his garden entirely to him; and Quintinie applied so closely to it, that he became famous all over France. Louis XIV. erected a new office purposely for him, that of director of the royal fruit and kitchen gardens; and these gardens, while he lived, were the admiration of the curious. He lived to a good old age, though we learn not the time of his death; his *Directions for the Management of Fruit and Kitchen Gardens* are esteemed all over Europe.

QUINTUS CALABER, a Greek poet, who wrote a large Supplement to Homer's Iliad, in 14 books, in which a relation is given of the Trojan war from the death of Hector to the destruction of Troy. It is conjectured, from his style and manner, that he lived in the fifth century. Nothing certain can be collected either

Vol. XV. Part II.

concerning his person or country. His poem was first made known by Cardinal Bessarion, who discovered it in St Nicolas's church, near Otranto in Calabria; from whence the author was named *Quintus Calaber*. It was first published at Venice by Aldus, but it is not said in what year.

QUINTUS CURTIUS. See CURTIUS.

QUINZY, QUINSEY, or *Angina Peñoris*. See MEDICINE, n° 403.

QUIRE OF PAPER, the quantity of 24 or 25 sheets.

QUIRINALIA, in antiquity, a feast celebrated among the Romans in honour of Romulus.

QUIRITES, in Roman antiquity. In consequence of the agreement entered into by Romulus and Tatius king of the Sabines, Rome was to retain its name, taken from Romulus; and the people were to be called *Quirites*, from Cures, the principal town of the Sabines, a name used in all public addresses to the Roman people. — Dion. Hal. says, that each particular citizen was to be called *Romanus*, and the collective body of them *Quirites*; yet it appears by this ancient form of words used at funerals, *Ollus Quiris letho datus est*, that each private citizen was also called *Quiris*.

The origin of the word *Quirites*, which was at first peculiar to the Sabines, and became, in Romulus's time, the general name of the inhabitants of Rome, has been much sought for; and the most probable account antiquity gives us of it, is this: The word *Qyris*, according to Plutarch and some others, signified, in the Sabine language, both "a dart," and "a warlike deity armed with a dart." It is uncertain whether the god gave name to the dart, or the dart to the god. But be that as it will, this *Quiris*, or *Quirinus*, was either Mars or some other god of war; and the worship of *Qyris* continued in Rome all Romulus's reign: but after his death he was honoured with the name *Quirinus*, and took the place of the god *Quiris*.

QUIRK, in a general sense, denotes a subtilty or artful distinction.

QUIRK, in building, a piece of ground taken out of any regular ground-plot, or floor: thus, if the ground-plot were oblong or square, a piece taken out of a corner to make a court or yard, &c. is called a *quirk*.

QUISQUALIS, in botany: A genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the 31st order, *Veprecule*. The calyx is quinquesid and filiform; the petals five; the fruit is a quinqueangular plum. There is only one species, viz. *INDICA*.

QUITO, a town of South America, in Peru (see PERU, p. 213.), seated between two chains of high mountains called *Cordillera de los Andes*, on much higher ground than the rest of habitable Peru. It is 300 yards higher than the level of the sea according to the exactest observations. The town is 1600 yards long and 1200 broad, and is the seat of a bishop. It contains about 35,000 inhabitants, one third of whom are originally Spaniards. Among the inhabitants are some persons of high rank and distinction, descended either from the original conquerors, or persons who at different times came from Spain invested with some lucrative post. The number of these, however, is but small. The commonalty, besides Spaniards, consist of Mestizos, Indians, and Negroes; but the last are not

Quintus
||
Quito.

Quito
||
Quoin.

proportionally numerous. Merchandizes and commodities of all sorts are extremely dear, partly on account of the difficulty of bringing them.

There are several religious communities at Quito, and two colleges or universities governed by Jesuits and Dominicans.

The principal courts held at Quito are that of the royal audience, which consists of the president, who is governor of the province with regard to law affairs; four auditors, who are at the same time civil and criminal judges; a royal fiscal, who, besides the causes brought before the audience, takes cognizance of every thing relating to the revenue; and an officer styled the *protector of the Indians*, who solicits for them, and when they are injured pleads in their defence. The next is the treasury, the chief officers of which are an accountant, a treasurer, and a royal fiscal. The tribunal of the *Croisade*, which has a commissary, who is generally some dignitary of the church, and a treasurer. There is also a treasury for the effects of persons deceased: an institution established all over the Indies, for receiving the goods of those whose lawful heirs are in Spain, in order to secure them from those accidents to which they might be liable in private hands. There is likewise a commissary of the inquisition, with an alguazil-major and familiars, appointed by the inquisition at Lima. The corporation consists of a corregidor, two ordinary alcaldes, chosen annually, and regidores. The latter superintend the election of the alcaldes, which is attended with no small disturbance, the people being divided into two parties, the Creoles and Europeans.

QUITTER-BONE, in farriery. See there, § xl. 4.

QUIT-RENT (*quietus redditus*, i. e. "quiet rent,") is a certain small rent payable by the tenants of manors, in token of subjection, and by which the tenant goes quiet and free. In ancient records it is called *white rent*, because paid in silver money, to distinguish it from rent-corn, &c.

QUOIN, or COIN, on board a ship, a wedge fa-

stened on the deck close to the breach of the carriage of a gun, to keep it firm up to the ship's side. Cantic quoins are short three-legged quoins put between casks to keep them steady.

Quoin
||
Quotient.

QUOINS, in architecture, denote the corners of brick or stone walls. The word is particularly used for the stones in the corners of brick buildings. When these stand out beyond the brick-work, their edges being chamfred off, they are called *rustic quoins*.

QUOTIDIAN, any thing which happens every day. Hence, when the paroxysms of an ague recur every day, it is called a *quotidian ague*. See MEDICINE, n° 161—164.

QUOTIDIANA DECEPTIVA. See MEDICINE, n° 150.

QUOAD HOC, is a term used in the pleadings and arguments of lawyers; being as much as to say, As to this thing the law is so and so.

QUORUM, a word frequently mentioned in our statutes, and in commissions both of justices of the peace and others. It is thus called from the words of the commission, *quorum A. B. unum esse volumus*. For an example, where a commission is directed to seven persons, or to any three of them, whereof A. B. and C. D. are to be two; in this case, they are said to be of the quorum, because the rest cannot proceed without them: so a justice of the peace and quorum is one without whom the rest of the justices in some cases cannot proceed.

QUOTIENT, in arithmetic, the number resulting from the division of a greater number by a smaller; and which shows how often the smaller is contained in the greater, or how often the divisor is contained in the dividend. The word is formed from the Latin *quoties*; *q. d.* How often is such a number contained in such another?

In division, as the divisor is to the dividend, so is unity to the quotient.—Thus the quotient of 12 divided by 3 is 4; which is thus disposed, 3) 12 (4 quotient. See ARITHMETIC.

R.

R, or r, a liquid consonant, being the 17th letter of our alphabet. Its sound is formed by a guttural extrusion of the breath vibrated through the mouth, with a sort of quivering motion of the tongue drawn from the teeth, and canulated with the tip a little elevated towards the palate. In Greek words it is frequently aspirated with an *h* after it, as in *rhapsody*, *rhetoric*, &c. otherwise it is always followed by a vowel at the beginning of words and syllables.

In the notes of the ancients, R. or RO. signifies *Roma*; R. C. *Romana civitas*; R. G. C. *rei gerendæ causa*; R. F. E. D. *recte factum et dictum*; R. G. F. *regis filius*; R. P. *rei publica*, or *Romani principes*; and R. R. R. F. F. F. *res Romana ruet ferro, fame, flamma*.

Used as a numeral, R anciently stood for 80; and with a dash over it, thus \bar{R} , for 80,000; but the Greek ρ , ρ , with a small mark over it, signified 100; with the same mark under it, it denoted 1000×100 ; thus ρ signified 100,000. In the Hebrew numeration γ denoted 200; and with two horizontal points over it γ denoted 1000×200 ; thus γ = 200,000.

In the prescriptions of physicians, R or \bar{R} stands for *recipe*, i. e. "take."

RAAB, a town of Lower Hungary, capital of Javerin, with a castle and a bishop's see. It is a strong frontier bulwark against the Turks, and has two bridges, one over a double ditch, and another that leads towards Alba Regalis. The surrounding country is plain, and there

Rabac
||
Rabbetting.

there is nothing that seems to command it but a small hill at some distance, which is undermined and may be blown up. It was taken by Amurath III. with the loss of 20,000 men; but was surprised soon after by Count Palfi, who killed all the Turks that were found therein. It is seated at the confluence of the rivers Rab and Rabbitz, not far from the Danube, 32 miles west of Gran, and 55 south-east of Vienna. E. Long. 17. 25. N. Lat. 47. 48.

RABAC, a small port on the Arabian coast of the Red Sea, in N. Lat. 22° 35' 40" by Mr Bruce's account. The entry to the harbour is from the E. N. E. and is about a quarter of a mile broad. The port extends about two miles in length to the eastward. The mountains are about three leagues to the north, and the town about four miles north by east from the entrance to the harbour. The water is good, and all ships may be supplied here from the wells which are in the neighbourhood of the town. The country is bare and uncultivated; but from the appearance of it, and the freshness of the water, Mr Bruce supposes that it sometimes rains among the mountains here, which is the more probable as it is considerably within the tropic.

RABAT, a large and handsome sea-port town of Africa, in the kingdom of Fez and province of Tremesen. It has fine mosques and handsome palaces, and is seated at the mouth of the river Burrigrig, almost in the mid-way between Fez and Tangier. W. Long. 5. 28. N. Lat. 34. 40.

Rabat, together with Salée, which is opposite to it, was formerly famous for fitting out piratical vessels; but the late emperor Sidi Mahomet subdued them both, and annexed them to the empire; since which time the harbour of Rabat has been so filled with the sand washed in by the sea as to render it unfit to carry on such piracies in future.

The town of Rabat, whose walls inclose a large space of ground, is defended on the sea-side by three forts tolerably well finished, which were erected some little time ago by an English renegado, and furnished with guns from Gibraltar. The houses in general are good, and many of the inhabitants are wealthy. The Jews, who are very numerous in this place, are generally in better circumstances than those of Larache or Tangier, and their women are extremely beautiful.

The castle, which is very extensive, contains a strong building, formerly used by the late emperor as his principal treasury, and a noble terrace, which commands an extensive prospect of the town of Salée, the ocean, and all the neighbouring country. There are also the ruins of another castle, which is said to have been built by Jacob Almonzor, one of their former emperors, and of which at present very little remains but its walls, containing within them some very strong magazines for powder and naval stores. On the outside of these walls is a very high and square tower, handsomely built of cut stone, and called the tower of *Haffen*. From the workmanship of this tower, contrasted with the other buildings, a very accurate idea may be formed how greatly the Moors have degenerated from their former splendour and taste for architecture.

RABBETTING, in carpentry, the planning or cutting of channels or grooves in boards, &c.

In ship-carpentry, it signifies the letting in of the planks of the ship into the keel; which, in the rake and

run of a ship, is hollowed away, that the planks may join the closer.

RABBI, or RABBINS, a title which the Pharisees and doctors of the law among the Jews assumed, and literally signifies *masters* or *excellents*.

There were several gradations before they arrived at the dignity of a rabbin; which was not conferred till they had acquired the profoundest knowledge of the law and the traditions. It does not, however, appear that there was any fixed age or previous examination necessary; but when a man had distinguished himself by his skill in the written and oral law, and passed through the subordinate degrees, he was saluted a rabbin by the public voice.

Among the modern Jews, for near 700 years past, the learned men retain no other title than that of *rabbi*, or *rabbins*; they have great respect paid them, have the first places or seats in their synagogues, determine all matters of controversy, and frequently pronounce upon civil affairs; they have even power to excommunicate the disobedient.

RABBINISTS, among the modern Jews, an appellation given to the doctrine of the rabbins concerning traditions, in opposition to the Caraites; who reject all traditions. See CARAITE.

RABELAIS (Francis), a French writer famous for his facetiousness, was born at Chinon in Touraine about the year 1483. He was first a Franciscan friar; but quitting his religious habit studied physic at Montpellier, where he took his doctor's degree. It is said, that the chancellor du Pratt having abolished the privileges of the faculty of physic at Montpellier by a decree of the parliament, Rabelais had the address to make him revoke what he had done; and that those who were made doctors of that university wore Rabelais's robe, which is there held in great veneration. Some time after, he came to Rome, in quality of physician in ordinary to Cardinal John du Bellay archbishop of Paris. Rabelais is said to have used the freedom to jeer Pope Paul III. to his face. He had quitted his religious connections for the sake of leading a life more agreeable to his taste; but renewed them on a second journey to Rome, when he obtained, in 1536, a brief to qualify him for holding ecclesiastical benefices; and, by the interest of his friend Cardinal John du Bellay, he was received as a secular canon in the abbey of St Maur near Paris. His profound knowledge in physic rendered him doubly useful; he being as ready, and at least as well qualified, to prescribe for the body as for the soul: but as he was a man of wit and humour, many ridiculous things are laid to his charge, of which he was quite innocent. He published several things; but his chief performance is a strange incoherent romance, called the *History of Gargantua and Pantagruel*, being a satire upon priests, popes, fools, and knaves of all kinds. This work contains a wild, irregular profusion of wit, learning, obscenity, low conceits, and arrant nonsense; hence the shrewdness of his satire, in some places where he is to be understood, gains him credit for those where no meaning is discoverable. Some allusions may undoubtedly have been so temporary and local as to be now quite lost: but it is too much to conclude thus in favour of every unintelligible rhapsody; for we are not without English writers of great talents, whose sportive geniuses have betrayed them into puerilities, no less incoherent at

Rabbi
||
Rabelais.

Rabbit. the times of writing than those of Rabelais appear above two centuries after. He died about 1553.

RABBIT, in zoology. See LEPUS.

The buck rabbits, like our boar cats, will kill the young ones if they can get at them; and the does in the warrens prevent this, by covering their stocks, or nests, with gravel or earth, which they close so artificially up with the hinder part of their bodies, that it is hard to find them out. They never suckle their young ones at any other time than early in the morning and late at night; and always, for eight or ten days, close up the hole at the mouth of the nest, in this careful manner when they go out. After this they begin to leave a small opening, which they increase by degrees; till at length, when they are about three weeks old, the mouth of the hole is left wholly open that they may go out; for they are at that time grown big enough to take care of themselves, and to feed on grass.

People who keep rabbits tame for profit, breed them in hutches; but these must be kept very neat and clean, else they will be always subject to diseases. Care must be taken also to keep the bucks and does apart till the latter have just kindled; then they are to be turned to the bucks again, and to remain with them till they shun and run from them.

The general direction for the choosing of tame rabbits is, to pick the largest and fairest; but the breeder should remember that the skins of the silver-haired ones sell better than any other. The food of the tame rabbits may be colewort and cabbage-leaves, carrots, parsneps, apple-rinds, green corn, and vetches, in the time of the year; also vine-leaves, grass, fruits, oats, and oatmeal, milk-thistles, fow-thistles, and the like: but with these moist foods they must always have a proportionable quantity of the dry foods, as hay, bread, oats, bran, and the like, otherwise they will grow pot-bellied, and die. Bran and grains mixed together have been also found to be very good food. In winter they will eat hay, oats, and chaff, and these may be given them three times a-day; but when they eat green things, it must be observed that they are not to drink at all, for it would throw them into a dropsy. At all other times a very little drink serves their turn, but that must always be fresh. When any green herbs or grass are cut for their food, care must be taken that there be no hemlock among it; for though they will eat this greedily among other things when offered to them, yet it is hidden poison to them.

Rabbits are subject to two principal infirmities. First, the rot, which is caused by giving them too large a quantity of greens, or from giving them fresh gathered with the dew or rain hanging in drops upon them. It is over-moisture that always causes this disease. The greens therefore are always to be given dry; and a sufficient quantity of hay, or other dry food, intermixed with them, to take up the abundant moisture of their juices. On this account the very best food that can be given them, is the shortest and sweetest hay that can be got, of which one load will serve 200 couples a year; and out of this stock of 200, 200 may be eat in the family, 200 sold to the markets, and a sufficient number kept in case of accidents.

The other general disease of these creatures is a sort of madness: this may be known by their wallowing and tumbling about with their heels upwards, and hop-

ping in an odd manner into their boxes. This distemper is supposed to be owing to the rankness of their feeding; and the general cure is the keeping them low, and giving them the prickly herb called *tare-bistle* to eat.

The general computation of males and females is, that one buck-rabbit will serve for nine does: some allow 10 to one buck; but those who go beyond this always suffer for it in their breed.

The wild rabbits are either to be taken by small cur-dogs, or by spaniels bred up to the sport; and the places of hunting those who straggle from their burrows, is under close hedges or bushes, or among corn-fields and fresh pastures. The owners use to course them with small greyhounds; and though they are seldom killed this way, yet they are driven back to their burrows, and are prevented from being a prey to others. The common method is by nets called *purse-nets*, and ferrets. The ferret is sent into the hole to fetch them out; and the purse-net being spread over the hole, takes them as they come out. The ferrets mouths must be muffled, and then the rabbit gets no harm. For the more certain taking of them, it may not be improper to pitch up a hay-net or two, at a small distance from the burrows that are intended to be hunted: thus very few of the number that are attempted will escape.

Some who have not ferrets smoke the rabbits out of their holes with burning brimstone and orpiment. This certainly brings them out into the nets: but then it is a very troublesome and offensive method; and is very detrimental to the place, as no rabbit will for a long time afterwards come near the burrows which have been fumed with those stinking ingredients.

The testicle of a rabbit is a very good object for examining the structure of this part of generation in animals. The whole substance of the testicle in this animal is made up of vessels, which lie in round folds in the manner of the smaller intestines: but then both ends of each roll meet at their insertion, which seems to be made into the *duæus nervosus*; and every one of these little rolls is curiously embroidered with other vessels, which, from their red colour, appear to be arteries and veins. The several little rolls lie in ranges, disposed with an uniformity which is very agreeable to the eye. Every one of these rolls is not a single and entire tube, but each consists of several tubes, beside the veins and arteries which embroider it. This is best distinguished by the cutting one of the rolls transversely, and then examining the cut end with a glass, which will appear to be made up of the cut and open ends of four, five, or more parallel tubes, which together form the roll, or single tube, as it appears to the eye, being all wrapped up in one common and very thin membrane. These are so tender that they cannot be explicated and viewed distinct, as De Graaf tells us those of the testicles of a rat and of some other animals may. These, however, as well as the others, are only made up of a congeries of vessels, and the liquors, which are their contents, without any intermediate substance, or any thing of that parenchyma which many authors have talked of. The testicles of a bull have the greatest appearance of a fleshy texture of those of any known animal; yet even these afford no particle of parenchyma, or flesh, when examined by glasses in any sort of preparation, whether boiled, raw, soaked in spirits, or in whatever other state.

The

Rabirius
||
Racine.

The testicles of various animals are very variously composed, but all in this general manner of vessels variously rolled and folded together: and even the human testicles are of the same sort; being composed solely of rolls of vessels, without any intermediate substance, be it called by whatever name, but only consisting of vessels and their liquors.

RABIRIUS (C.) a Roman knight, who lent an immense sum of money to Ptolemy Auletes king of Egypt. The monarch afterwards not only refused to repay him, but even confined him, and endangered his life. Rabirius escaped from Egypt with difficulty; but at his return to Rome he was accused by the senate of having lent money to an African prince for unlawful purposes. He was ably defended by Cicero, and acquitted with difficulty.—There was a Latin poet of the same name in the age of Augustus. He wrote a poem on the victory which the emperor had gained over Antony at Actium. Seneca has compared him to Virgil for elegance and majesty; but Quintilian is not so favourable to his poetry.—And there was an architect in the reign of Domitian, called *Rabirius*. He built a celebrated palace for the emperor, of which the ruins are still seen at Rome.

RACCOON. See *URSUS*.

RACE, in general, signifies running with others in order to obtain a prize, either on foot, or by riding on horseback, in chariots, &c.

The race was one of the exercises among the ancient Grecian games, which was performed in a course containing 125 paces; and those who contended in these foot-races were frequently clothed in armour. Chariot and horse races also made a part of these ancient games.

Races were known in England in very early times. Fitz-Stephen, who wrote in the days of Henry II. mentions the great delight that the citizens of London took in the diversion. But by his words, it appears not to have been designed for the purposes of gaming, but merely to have sprung from a generous emulation of showing a superior skill in horsemanship.

Races appear to have been in vogue in the reign of Queen Elizabeth, and to have been carried to such excesses as to injure the fortunes of the nobility. The famous George earl of Cumberland is recorded to have wasted more of his estate than any of his ancestors; and chiefly by his extreme love to horse-races, tiltings, and other expensive diversions. It is probable that the parsimonious queen did not approve of it; for races are not among the diversions exhibited at Kenilworth by her favourite Leicester. In the following reign, were places allotted for the sport: Croydon in the south, and Garterly in Yorkshire, were celebrated courses. Camden also says, that in 1607 there were races near York, and the prize was a little golden bell. See *RACING*.

RACE, in genealogy, a lineage or extraction continued from father to son. See *DESCENT*.

RACINE (John), of the French academy, treasurer of France in the generality of Moulins, and secretary to his majesty, was born at Ferre-Milon in 1639. He had a fine genius for the *Belles Lettres*, and became one of the first poets of the age. He produced his *Thebnide* when but very young; and afterwards other pieces, which met with great success, though they appeared when Corneille was in his highest repu-

tation. In his career, however, he did not fail to meet with all that opposition which envy and cabal are ever ready to set up against a superior genius. It was partly owing to a chagrin from this circumstance that he took a resolution to quit the theatre for ever; although his genius was still in full vigour, being not more than 38 years of age. But he had also imbibed in his infancy a deep sense of religion; and this, though it had been smothered for a while by his connections with the theatre, and particularly with the famous actress Champmelle, whom he greatly loved, and by whom he had a son, now at length broke out, and bore down all before it. In the first place, he resolved not only to write no more plays, but to do a rigorous penance for those he had written; and he actually formed a design of becoming a Carthusian friar. His religious director, however, a good deal wiser than he, advised him to think more moderately, and to take measures more suitable to his character. He put him upon marrying, and settling in the world: with which proposal this humble and tractable penitent complied; and immediately took to wife the daughter of a treasurer of France for Amiens, by whom he had seven children.

He had been admitted a member of the French academy in 1673, in the room of La Mothe le Vayer deceased; but spoiled the speech he had made upon that occasion by pronouncing it with too much timidity. In 1677, he was nominated with Boileau, with whom he was ever in strict friendship, to write the history of Louis XIV.; and the public expected great things from two writers of their distinction, but were disappointed. Boileau and Racine, after having for some time laboured at this work, perceived that it was entirely opposite to their genius.

He spent the latter years of his life in composing a history of the house of Port-Royal, the place of his education; which, however, though finely drawn up, as many have asserted, has not been published. Too great sensibility, say his friends, but more properly an impotence of spirit, shortened the days of this poet.—Though he had conversed much with the court, he had not learned the wisdom, which is usually learned there, of disguising his real sentiments. Having drawn up a well-reasoned and well-written memorial upon the miseries of the people, and the means of relieving them, he one day lent it to Madam de Maintenon to read; when the king coming in, and demanding what and whose it was, commended the zeal of Racine, but disapproved of his meddling with things that did not concern him: and said with an angry tone, “Because he knows how to make good verses, does he think he knows every thing? And would he be a minister of state, because he is a great poet?” These words hurt Racine greatly: he conceived dreadful ideas of the king’s displeasure; and his chagrin and fears brought on a fever, of which he died the 22d of April 1699.

The king, who was sensible of his great merit, and always loved him, sent often to him in his illness; and finding after his death that he had more glory than riches, settled a handsome pension upon his family.—There is nothing in the French language written with more wit and elegance than his pieces in prose. Besides his plays, several of his letters have been published; he also wrote spiritual songs, epigrams, &c. Racine’s
works.

Racine.

Racing.

works were printed at Amsterdam in 1722, in 2 vols 12mo, and the next year a pompous edition was printed in 2 vols quarto.

RACING, the riding heats for a plate, or other premium. See PLATE. The amusement of horseracing, which is now so common, was not unknown among the great nations of antiquity, nor wholly unpractised by our ancestors in Britain, as we have already mentioned in the article RACE. In 1599, private matches between gentlemen, who were their own jockies and riders, were very common; and, in the reign of James I. public races were established at various places, when the discipline, and mode of preparing the horses for running, &c. were much the same as they are now. The most celebrated races of that time were called bell-courses, the prize of the conqueror being a bell: hence, perhaps, the phrase of *bearing the bell*, when applied to excellence, is derived. In the latter end of Charles I.'s reign, races were performed in Hyde-Park. Newmarket was also a place for the same purpose, though it was first used for hunting. Racing was revived soon after the Restoration, and much encouraged by Charles II. who appointed races for his own amusement at Datchet Mead, when he resided at Windsor. Newmarket, however, now became the principal place. The king attended in person, established a house for his own accommodation, and kept and entered horses in his own name. Instead of bells, he gave a silver bowl or cup value 100 guineas; on which prize the exploits and pedigree of the successful horse were generally engraved. Instead of the cup or bowl, the royal gift is now a hundred guineas. William III. not only added to the plates, but even founded an academy for riding; and Queen Anne continued the bounty of her ancestors, adding several plates herself. George I. towards the end of his reign, discontinued the plates, and gave in their room a hundred guineas. An act was passed in the 13th year of the reign of George II. for suppressing races by ponies and other small and weak horses, &c. by which all matches for any prize under the value of 50 l. are prohibited, under a penalty of 200 l. to be paid by the owner of each horse running, and 100 l. by such as advertise the plate; and by which each horse entered to run, if five years old, is obliged to carry ten stones; if six, eleven; and if seven, twelve. It is also ordained, that no person shall run any horse at a course, unless it be his own, nor enter more than one horse for the same plate, upon pain of forfeiting the horses; and also every horse-race must be begun and ended in the same day. Horses may run for the value of 50 l. with any weight, and at any place. 13 Geo. II. cap. 19. 18 George II. cap. 34. Pennant's British Zoology, vol. i. p. 6, &c. Berenger's History and Art of Horsemanship, vol. i. p. 185, &c. At Newmarket there are two courses, the long and the round: the first is exactly four miles and about 380 yards, *i. e.* 7420 yards. The second is 6640 yards. Childers, the swiftest horse ever known, has run the first course in seven minutes and a half, and the second in six minutes forty seconds; which is at the rate of more than forty-nine feet in a second. But all other horses take up at least seven minutes and fifty seconds in completing the first and longest course, and seven minutes only in the shortest, which is at the rate of more than forty-seven feet in a second. And it is commonly supposed

that these courses cover, at every bound, a space of ground in length about twenty-four English feet. Race-horses have been for some time an object of taxation.

RACHITIS, the RICKETS. See MEDICINE, n° 347.

RACK (Edmund), a person well known in the literary world by his attachment to; and promotion of, agricultural knowledge: he was a native of Norfolk, a Quaker. His education was common, and he was apprenticed originally to a shopkeeper: his society was select in this situation, and by improving himself in learning, his conversation was enjoyed by a respectable acquaintance. He wrote many essays, poems, and letters, and some few controversial tracts. At length he settled, about his 40th year, at Bath in 1775, and was soon introduced to the most eminent literati of that place, among whom Dr Wilson and Mrs Macaulay highly esteemed him for his integrity and abilities. In 1777 he published *Mentor's Letters*, a moral work, which has run through many editions. But this year he gained great celebrity by his plan of an agricultural society, which was soon adopted by four counties. He still further advanced his fame by his papers in the Farmer's Magazine, and his communications in the Bath Society's papers; a work remarkable for its ingenuity and spirit. His last engagement was in the History of Somersetshire, where the topographical parochial surveys were his. This work, in 3 vols 4to, was published in 1791, by his colleague the Reverend Mr Collinson.—Mr Rack died of an asthma in February 1787, aged 52.

RACK, an engine of torture, furnished with pulleys, cords, &c. for extorting confession from criminals.—The trial by rack is utterly unknown to the law of England; though once, when the dukes of Exeter and Suffolk, and other ministers of Henry VI. had laid a design to introduce the civil law into this kingdom as the rule of government; for a beginning thereof they erected a rack for torture, which was called in derision the duke of Exeter's daughter, and still remains in the Tower of London, where it was occasionally used as an engine of state, not of law, more than once in the reign of Queen Elizabeth. But when, upon the assassination of Villiers duke of Buckingham, by Felton, it was proposed in the privy council to put the assassin to the rack, in order to discover his accomplices; the judges, being consulted, declared unanimously, to their own honour and the honour of the English law, that no such proceeding was allowable by the laws of England. It seems astonishing that this usage of administering the torture should be said to arise from a tenderness to the lives of men; and yet this is the reason given for its introduction in the civil law, and its subsequent adoption by the French and other foreign nations, viz. because the laws cannot endure that any man should die upon the evidence of a false, or even a single witness, and therefore contrived this method that innocence should manifest itself by a stout denial, or guilt by a plain confession: thus rating a man's virtue by the hardness of his constitution, and his guilt by the sensibility of his nerves. The Marquis Beccaria, in an exquisite piece of raillery, has proposed this problem, with a gravity and precision that are truly mathematical: "The force of the muscles and the sensibility of the nerves of an innocent person being given; it is required to find the degree of pain necessary to make him confess

Rachitis,
Rack.

Rack
||
Radcliffe.

confess himself guilty of a given crime." See *Act of Faith, Inquisition, and Torture*.

RACK, a spirituous liquor made by the Tartars of Tongusta. This kind of rack is made of mare's milk, which is left to be four, and afterwards distilled twice or thrice between two earthen pots closely stopped; whence the liquor runs through a small wooden pipe. This liquor is more intoxicating than brandy distilled from wine.

RACK, or *Arack*. See ARACK.

To Rack Wines, &c. To draw them off from their lees, after having stood long enough to ebb and settle. Hence rack-vintage is frequently used for the second voyage our wine-merchants use to make into France for racked wines.

RACKOON, in zoology, a species of *Ursus*.

RACONI, a populous town of Italy, in Piedmont, seated in a pleasant plain, on the road from Savillan to Turin, on the rivers Grana and Macra. It belongs to the prince of Carignan, who has a handsome castle here. It is six miles from Savillan, and six from Carignan. E. Long. 7. 46. N. Lat. 44. 39.

RADCLIFFE (Dr John), an English physician of great eminence in his time, born at Wakefield in Yorkshire in 1630. He was educated at Oxford, and enrolled himself upon the physical line; but it was remarkable that he recommended himself more by his ready wit and vivacity, than by any extraordinary acquisitions in learning. He began to practise at Oxford in 1675; but never paid any regard to established rules, which he censured whenever he thought fit, with great freedom and acrimony; and as this drew all the old practitioners upon him, he lived in a continual state of hostility with them. Nevertheless, his reputation increased with his experience; so that, before he had been two years in business, his practice was very extensive among persons of high rank. In 1684 he removed to London, and settled in Bow-street, Covent Garden, where in less than a year he got into prime business. — In 1687 the princess Anne of Denmark made him her physician: yet when her husband and she joined the prince of Orange, Radcliffe, either not choosing to declare himself, or unwilling to favour the measures then in agitation, excused himself from attending them, on the plea of the multitude of his patients. Nevertheless, he was often sent for to King William and other great personages, though he did not incline to be a courtier. He incurred some censure for his treatment of Q. Mary, who died of the small-pox; and soon after lost his place about the princess Anne, by his attachment to his bottle. He also totally lost the favour of K. William by his uncourtly freedom; for, in 1699, when the king showed him his swollen ankles, while the rest of his body was emaciated, and asked him what he thought of them? "Why truly I would not have your majesty's two legs for your three kingdoms," replied Radcliffe. He continued increasing in business and insolence as long as he lived, continually at war with his brethren the physicians; who considered him in no other light than that of an active ingenious empiric, whom constant practice had at length brought to some degree of skill in his profession. He died in 1714; and if he never attempted to write any thing himself, has perpetuated his memory by founding a fine library at Oxford, to preserve the writings of other men.

RADIALIS, the name of two muscles in the arm. See ANATOMY, *Table of the Muscles*.

Radialis
||
Raft.

RADIANT, in optics, is any point of a visible object from whence rays proceed.

RADIATED FLOWERS, in botany, are such as have several semistyles set round a disk, in form of a radiant star; those which have no such rays are called *disinous flowers*.

RADIATION, the act of a body emitting or diffusing rays of light all round as from a centre.

RADICAL, in general, something that serves as a basis or foundation. Hence physicians talk much of a radical moisture. In grammar, we give the appellation *radical* to primitives, in contradistinction to compounds and derivatives. Algebrists also speak of the radical sign of quantities, which is the character expressing their roots.

RADICLE, that part of the seeds of all plants which upon vegetating becomes their root, and is discoverable by the microscope. See PLANT.

RADISH, in botany. See RAPHANUS.

RADIUS, in geometry, the semidiameter of a circle, or a right line drawn from the centre to the circumference.

In trigonometry, the radius is termed the whole sine, or sine of 90°. See SINE.

RADIUS, in anatomy, the exterior bone of the arm, descending along with the ulna from the elbow to the wrist.

RADNOR, the county-town of Radnorshire, in South Wales. It is a poor little place, distant from London about 150 miles. It is situated near the spring-head of the river Somergil, in a fruitful valley at the bottom of a hill, where there are sheep grazing in abundance. It is a very ancient borough-town, whose jurisdiction extends near 12 miles round about: the government of it is vested in a bailiff and 25 burgesses. Though it is the county-town, the assizes are held at Presteign: it has one privilege, however, that is very extraordinary, besides that of sending one member to parliament; and that is, it keeps a court of pleas for all actions, without being limited to any particular sum. It was formerly fenced with a wall and a strong castle; but both were in a great measure demolished by Owen Glendower, when he assumed the title of Prince of Wales, upon the deposition of King Richard II. W. Long. 2. 45. N. Lat. 52. 10.

RADNORSHIRE, a county of South Wales, is bounded on the north by Montgomeryshire; on the east by Shropshire and Herefordshire; on the south and south-west by Brecknockshire; and on the west by Cardiganshire; extending 30 miles in length and 25 in breadth. This county is divided into six hundreds, in which are contained three market-towns, 52 parishes, about 3160 houses, and 18,967 inhabitants. It is seated in the diocese of Hereford, and sends two members to parliament, one for the county and one for the town of Radnor. The air of this county is in winter cold and piercing. The soil in general is but indifferent; yet some places produce corn, particularly the eastern and southern parts; but in the northern and western, which are mountainous, the land is chiefly stocked with horned cattle, sheep, and goats.

RADIX. See ROOT.

RAFT, a sort of float, formed by an assemblage of various

Rafters
||
Ragusa.

various planks or pieces of timber, fastened together side by side, so as to be conveyed more commodiously to any short distance in a harbour or road than if they were separate. The timber and plank with which merchant-ships are laden, in the different parts of the Baltic Sea, are attached together in this manner, in order to float them off to the shipping.

RAFTERS, in building, are pieces of timber which, standing by pairs on the rafter or rafter piece, meet in an angle at the top, and form the roof of a building. See ARCHITECTURE.

ROWLEY RAGG, a genus of stones, belonging to the siliceous class. It is of a dusky or dark grey colour, with many small shining crystals, having a granular texture, and acquiring an ochry crust by exposure to the air. The specific gravity is 2748. It becomes magnetic by being heated in an open fire. In a strong fire it melts without addition, but with more difficulty than basalt. It was analysed by Dr Withering, who found that 100 parts of it contain 47.5 of siliceous earth, 32.5 of argil, and 20 of iron.

RAGMAN'S ROLL, *Rectius* Ragimund's roll, so called from one Ragimund a legate in Scotland, who calling before him all the beneficed clergymen in that kingdom, caused them on oath to give in *the true value* of their benefices; according to which they were afterwards taxed by the court of Rome; and this roll, among other records, being taken from the Scots by Edward I. was redelivered to them in the beginning of the reign of Edward III.

RAGOUT, or RAGOO, a sauce, or seasoning, intended to rouse the appetite when lost or languishing.

This term is also used for any high-seasoned dish prepared of flesh, fish, greens, or the like: by stewing them with bacon, salt, pepper, cloves, and the like ingredients. We have ragouts of celery, of endive, asparagus, cock's combs, giblets, craw-fish, &c.

The ancients had a ragout called *garum*, made of the putrified guts of a certain fish kept till it dissolved into a mere sanies, which was thought such a dainty, that, according to Pliny, its price equalled that of the richest perfumes.

RAGSTONE, a genus of stones belonging to the class of siliceous earths. It is of a grey colour; the texture obscurely laminar, or rather fibrous; but the laminæ or fibres consist of a congeries of grains of a quartz appearance, coarse and rough. The specific gravity is 2729; it effervesces with acids, and strikes fire with steel. Mr Kirwan found it to contain a portion of mild calareous earth, and a small proportion of iron. It is used as a whetstone for coarse cutting tools. It is found about Newcastle, and many other parts of England, where there are large rocks of it in the hills.

RAGULED, or RAGGED, in heraldry, jagged or knotted. This term is applied to a cross formed of the trunks of two trees without their branches, of which they show only the stumps. *Raguled* differs from *indent-ed*, in that the latter is regular, the former not.

RAGUSA, an ancient town of Sicily, in the Val-di-Noto, near the river Maulo, 12 miles north of Modica. E. Long. 14. 59. N. Lat. 37. 0.

RAGUSA, a city of Dalmatia, and capital of Ragusen. It is about two miles in circumference, is pretty well built, and strong by situation, having an inaccessible mountain on the land-side, and on the side of the

sea a strong fort. It has an archbishop's see and a republic, and has a doge like that of Venice, but he continues a month only in his office. It carries on a considerable trade with the Turks, and is 60 miles north-west of Scutari, and 110 north of Brindisi. E. Long. 18. 10. N. Lat. 42. 50.

RAGUSEN, a territory of Europe in Dalmatia, lying along the coast of the gulph of Venice, about 55 miles in length, and 20 in breadth. It is a republic under the protection of the Turks and Venetians. Ragusa is the capital town.

RAJA, the title of the Indian black princes, the remains of those who ruled there before the Moguls. Some of the rajas are said to preserve their independency, especially in the mountainous parts; but most of them pay an annual tribute to the Mogul. The Indians call them *rai*; the Persians, *raian*, in the plural; and our travellers *rajas*, or *ragias*.

RAJA, the *Ray-Fish*, in ichthyology; a genus belonging to the order of Chondropterygia. There are five spiracula below towards the peak; the body compressed; and the mouth is situated under the head. The most remarkable species are,

1. The batis, or skate: this species is the thinnest in proportion to its bulk of any of the genus, and also the largest, some weighing near 200 pounds. The nose, though not long, is sharp pointed; above the eyes is a set of short spines: the upper part is of a pale brown, sometimes streaked with black: the lower part is white, marked with great numbers of minute black spots. The jaws are covered with small granulated but sharp-pointed teeth. The tail is of a moderate length: near the end are two fins: along the top of it is one row of spines, and on the edges are irregularly dispersed a few others, which makes us imagine with Mr Ray, that in this respect these fish vary, some having one, others more orders of spines on the tail. It is remarked, that in the males of this species the fins are full of spines. Skates generate in March and April; at which time they swim near the surface of the water, several of the males pursuing one female. They adhere so fast together in coition, that the fishermen frequently draw up both together, though only one has taken the bait. The females begin to cast their *purfes*, as the fishermen call them (the bags in which the young are included) in May, and continue doing it till September. In October they are exceedingly poor and thin; but in November they begin to improve, and grow gradually better till May, when they are in the highest perfection. The males go sooner out of season than the females.

2. The oxyrinchus, or sharp-nosed ray, in length near seven feet, and breadth five feet two inches; when just brought on shore, it makes a remarkable snorting noise. The nose is very long, narrow, and sharp-pointed, not unlike the end of a spout. The body is smooth, and very thin in proportion to the size; the upper part ash-coloured, spotted with numerous white spots, and a few black ones. The tail is thick; towards the end are two small fins; on each side is a row of small spines, with another row in the middle, which runs some way up the back. The lower part of the fish is quite white. The mouth is very large, and furnished with numbers of small sharp teeth bending inwards. This fish has been supposed to be the *bas* of the ancients;

Ragusan,
Raja.

* *Ulloa's*
Voyage,
L. 132.

ents; which was certainly some enormous species of ray, though we cannot pretend to determine the particular kind. Oppian styles it, *the broadest among fishes*: he adds an account of its fondness of human flesh, and the method it takes of destroying men, by over-laying and keeping them down by its vast weight till they are drowned. Phile (*De propriet. anim.* p. 85.) gives much the same relation. We are inclined to give them credit, since a modern writer, of undoubted authority *, gives the very same account of a fish found in the South Seas, the terror of those employed in the pearl-fishery. It is a species of ray, called there *man-ta*, or the *quilt*, from its surrounding and wrapping up the unhappy divers till they are suffocated; therefore the negroes never go down without a sharp knife to defend themselves against the assaults of this terrible enemy.

3. The aspera, or rough ray, is found in Loch-Broom in Scotland. The length from the nose to the tip of the tail is two feet nine. The tail is almost of the same length with the body. The nose is very short. Before each eye is a large hooked spine; and behind each another, beset with lesser. The upper part of the body is of a cinereous brown mixed with white, and spotted with black; and entirely covered with small spines. On the tail are three rows of great spines: all the rest of the tail is irregularly beset with lesser. The fins and under side of the body are equally rough with the upper. The teeth are flat and rhomboidal.

4. The fullonica, or fuller, derives its Latin name from the instrument fullers make use of in smoothing cloth, the back being rough and spiney. The nose is short and sharp. At the corner of each eye are a few spines. The membrane of nictitation is fringed. Teeth small and sharp. On the upper part of the pectoral fins are three rows of spines pointing towards the back, crooked like those on a fuller's instrument. On the tail are three rows of strong spines: the middle row reaches up part of the back. The tail is slender, and rather longer than the body. The colour of the upper part of the body is cinereous, marked usually with numerous black spots: the lower part is white. This, as well as most other species of rays, vary a little in colour, according to age. This grows to a size equal to the skate. It is common at Scarborough, where it is called the *white hans*, or *gullet*.

5. The shagreen ray increases to the size of the skate; is fond of launces or sand-eels, which it takes generally as a bait. The form is narrower than that of the common kinds; the nose long and very sharp; pupil of the eye sapphirine; on the nose are two short rows of spines; on the corner of the eyes another of a semicircular form; on the tail are two rows, continued a little up the back, small, slender, and very sharp: along the sides of the tail is a row of minute spines, intermixed with innumerable little spiculæ. The upper part of the body is of a cinereous brown, covered closely with shagreen-like tubercles, resembling the skin of the dog-fish: the under side of the body is white; from the nose to the beginning of the pectoral fins is a tuberculated space. The teeth slender, and sharp as needles.

6. The torpedo, cramp-fish, or electric ray, is frequently taken in Torbay: has been once caught off Pembroke, and sometimes near Waterford in Ireland. It is generally taken, like other flat fish, with the trawl; but there is an instance of its taking the bait. It com-

monly lies in water of about 40 fathoms depth; and in company with the congenerous rays. The torpedo brings forth its young at the autumnal equinox, as affirmed by Aristotle. A gentleman of La Rochelle, on dissecting certain females of this species, the 10th of September, found in the matrices several of the fœtuses quite formed, and nine eggs in no state of forwardness: superfœtation seems therefore to be a property of this fish. The food of the torpedo is fish; a furmullet and a plaife have been found in the stomach of two of them. The furmullet is a fish of that swiftness, that it was impossible for the torpedo to take it by pursuit. It is probable, therefore, that by their electric stroke they stupify their prey; yet the crab and sea-leech will venture to annoy them. They will live 24 hours out of the sea; and but very little longer if placed in fresh water. They inhabit sandy places; and will bury themselves superficially in it, by flinging the sand over, by a quick flapping of all the extremities. It is in this situation that the torpedo gives his most forcible shock, which throws down the astonished passenger who inadvertently treads upon him. In our seas it grows to a great size, and above 80 pounds weight. The tail is thick and round; the caudal fin broad and abrupt. The head and body, which are indistinct, are nearly round; attenuating to extreme thinness on the edges; below the body, the ventral fins form on each side a quarter of a circle. The two dorsal fins are placed on a trunk of the tail. The eyes are small, placed near each other: behind each is a round spiracle, with six small cutaneous rags on their inner circumference. Mouth small; teeth minute, spicular. Five openings to the gills, as in others of this genus. The skin everywhere smooth; cinereous brown above, white beneath. See further the article ELECTRICITY, n° 258—261.

7. The clavata, or thornback, is easily distinguished from the others by the rows of strong sharp spines disposed along the back and tail. In a large one seen by Mr Pennant, were three rows on the back, and five on the tail, all inclining towards its end. On the nose, and on the inner side of the forehead, near the eyes, were a few spines, and others were scattered without any order on the upper part of the pectoral fins. The mouth was small, and filled with granulated teeth: The upper part of the body was of a pale ash colour, marked with short streaks of black, and the skin rough, with small tubercles like shagreen. The belly white, crossed with a strong semilunar cartilage beneath the skin: in general, the lower part was smooth, having only a few spines on each side. The young fish have very few spines on them; and their backs are often spotted with white, and each spot is encircled with black. This species frequents our sandy shores; are very voracious, and feed on all sorts of flat fish; are particularly fond of herrings and sand-eels; and sometimes eat crustaceous animals, such as crabs. These sometimes weigh 14 or 15 pounds, but with us seldom exceed that weight. They begin to generate in June, and bring forth their young in July and August, which (as well as those of the skate) before they are old enough to breed, are called *maids*. The thornback begins to be in season in November, and continues so later than the skate, but the young of both are good at all times of the year.

8. The pastinaca, or sting ray, does not grow to the bulk of the others: The body is quite smooth, of shape almost round, and is of a much greater thickness and

Raja
Raillery.

more elevated form in the middle than any other rays, but grows thin towards the edges. The nose is very sharp pointed, but short; the mouth small, and filled with granulated teeth. The irides are of a gold colour: behind each eye the orifice is very large. The tail is very thick at the beginning: the spine is placed about a third the length of the former from the body; is about five inches long, flat on the top and bottom, very hard, sharp pointed, and the two sides thin, and closely and sharply bearded the whole way. The tail extends four inches beyond the end of this spine, and grows very slender at the extremity. These fish are observed to shed their spine, and renew them annually; sometimes the new spine appears before the old one drops off; and the Cornish call this species *cardinal trilest*, or *three-tailed*, when so circumstanced. The colour of the upper part of the body is a dirty yellow, the middle part of an obscure blue: the lower side white, the tail and spine dusky. The weapon with which nature has armed this fish, hath supplied the ancients with many tremendous fables relating to it. Pliny, Ælian, and Oppian, have given it a venom that affects even the inanimate creation: trees that are struck by it instantly lose their verdure and perish, and rocks themselves are incapable of resisting the potent poison. The enchantress Circe armed her son with a spear headed with the spine of the trygon, as the most irresistible weapon she could furnish him with; and with which he afterwards committed parricide, unintentionally, on his father Ulysses. That spears and darts might, in very early times, have been headed with this bone instead of iron, we have no kind of doubt; that of another species of this fish being still used to point the arrows of some of the South American Indians, and is, from its hardness, sharpness, and beards, a most dreadful weapon. But in respect to its venomous qualities, there is not the least credit to be given to the opinion, though it was believed (as far as it affected the animal world) by Rondeletius, Aldrovand, and others, and even to this day by the fishermen in several parts of the kingdom. It is in fact the weapon of offence belonging to the fish, capable of giving a very bad wound, and which is attended with dangerous symptoms when it falls on a tendinous part or on a person in a bad habit of body. As to any fish having a spine charged with actual poison, it seems very dubious, though the report is sanctified by the name of Linnæus. He instances the *pastinaca*, the *torpedo*, and the *tetrodon lineatus*. The first is incapable of conveying a greater injury than what results from the mere wound; the second, from its electric effluvia; and the third, by imparting a pungent pain like the sting of nettles, occasioned by the minute spines on its abdomen.

RAIANIA, in botany: A genus of the hexandria order, belonging to the dioecia class of plants; and in the natural method ranking under the 11th order, *Samentaceæ*. The male calyx is sexpartite; there is no corolla. The female calyx as in the male, without any corolla; there are three styles; the fruit is roundish with an oblique wing, inferior. There are three species, the hastata, cordata, and quinquefolia.

RAIETEA, one of the South Sea islands, named also ULIETEA.

RAIL, in ornithology. See RALLUS.

RAILLERY, according to Dr Johnson, means slight satire, or satirical merriment; and a beautiful writer of the last century compares it to a light which

dazzles, and which does not burn. It is sometimes innocent and pleasant, and it should always be so, but it is most frequently offensive. Raillery is of various kinds; there is a serious, severe, and good-humoured raillery; and there is a kind which perplexes, a kind which offends, and a kind which pleases.

To rally well, it is absolutely necessary that kindness run through all you say; and you must ever preserve the character of a friend to support your pretensions to be free with a man. Allusions to past follies, hints to revive what a man has a mind to forget for ever, should never be introduced as the subjects of raillery. This is not to thrust with the skill of fencers, but to cut with the barbarity of butchers. But it is below the character of men of humanity and good-breeding to be capable of mirth, while there is any in the company in pain and disorder.

RAIN, the descent of water from the atmosphere in the form of drops of a considerable size. By this circumstance it is distinguished from dew and fog: in the former of which the drops are so small that they are quite invisible; and in the latter, though their size is larger, they seem to have very little more specific gravity than the atmosphere itself, and may therefore be reckoned hollow spherules rather than drops.

It is universally agreed, that rain is produced by the water previously absorbed by the heat of the sun, or otherwise, from the terraqueous globe, into the atmosphere; but very great difficulties occur when we begin to explain why the water, once so closely united with the atmosphere, begins to separate from it. We cannot ascribe this separation to cold, since rain often takes place in very warm weather; and though we should suppose the condensation owing to the superior cold of the higher regions, yet there is a remarkable fact which will not allow us to have recourse to this supposition. It is certain that the drops of rain increase in size considerably as they descend. On the top of a hill, for instance, they will be small and inconsiderable, forming only a drizzling shower; but at the bottom of the same hill the drops will be excessively large, descending in an impetuous rain; which shows that the atmosphere is disposed to condense the vapours, and actually does so, as well where it is warm as where it is cold.

For some time the suppositions concerning the cause of rain were exceedingly insufficient and unsatisfactory. It was imagined, that when various congeries of clouds were driven together by the agitation of the winds, they mixed, and run into one body, by which means they were condensed into water. The coldness of the upper parts of the air also was thought to be a great means of collecting and condensing the clouds into water; which, being heavier than the air, must necessarily fall down through it in the form of rain. The reason why it falls in drops, and not in large quantities, was said to be the resistance of the air; whereby being broken, and divided into smaller and smaller parts, it at last arrives to us in small drops. But this hypothesis is entirely contrary to almost all the phenomena: for the weather, when coldest, that is, in the time of severe frost, is generally the most serene; the most violent rains also happen where there is little or no cold to condense the clouds; and the drops of rain, instead of being divided into smaller and smaller ones as they approach the earth, are plainly increased in size as they descend.

Rain.

Dr Derham accounted for the precipitation of the drops of rain from the vesiculæ being full of air, and meeting with an air colder than they contained, the air they contained was of consequence contracted into a smaller space; and consequently the watery shell rendered thicker, and thus specifically heavier, than the common atmosphere. But it has been shown, that the vesiculæ, if such they are, of vapour, are not filled with air, but with fire, or heat; and consequently, till they part with this latent heat, the vapour cannot be condensed. Now, cold is not always sufficient to effect this, since in the most severe frosts the air is very often serene, and parts with little or none of its vapour for a very considerable time. Neither can we admit the winds to have any considerable agency in this matter, since we find that blowing upon vapour is so far from condensing it, that it unites it more closely with the air, and wind is found to be a great promoter of evaporation.

§ See *Chemistry*, n^o 224, &c.

According to Rohault, the great cause of rain is the heat of the air; which, after continuing for some time near the earth, is raised on high by a wind, and there thawing the snowy villi or flocks of half-frozen vesicule, reduces them to drops; which, coalescing, descend. Here, however, we ought to be informed by what means these vesiculæ are suspended in their half-frozen state; since the thawing of them can make but little difference in their specific gravity, and it is certain that they ascended through the air not in a frozen but in an aqueous state.

Dr Clarke and others ascribe this descent of the rain rather to an alteration of the atmosphere than of the vesiculæ; and suppose it to arise from a diminution of the elastic force of the air. This elasticity, which, they say, depends chiefly or wholly upon terrene exhalations, being weakened, the atmosphere sinks under its burden, and the clouds fall. Now, the little vesicles being once upon the descent, will continue therein, notwithstanding the increase of resistance they every moment meet with. For, as they all tend to the centre of the earth, the farther they fall, the more coalitions they will make; and the more coalitions, the more matter will there be under the same surface; the surface increasing only as the squares, but the solidity as the cubes; and the more matter under the same surface, the less resistance will there be to the same matter. Thus, if the cold, wind, &c. act early enough to precipitate the ascending vesicles before they are arrived at any considerable height, the coalitions being but few, the drops will be proportionably small; and thus is formed a dew. If the vapours be more copious, and rise a little higher, we have a mist or fog. A little higher still, and they produce a small rain; if they neither meet with cold nor wind, they form a heavy thick dark sky. This hypothesis is equally unsatisfactory with the others; for, granting that the descent and condensation of the vapours are owing to a diminution of the atmosphere's elasticity, by what is this diminution occasioned? To say that it is owing to terrene exhalations, is only solving one difficulty by another; since we are totally unacquainted both with the nature and operation of these exhalations. Besides, let us suppose the cause to be what it will, if it acts equally and at once upon all the vapour in the air, then all that vapour must be precipitated at once; and thus,

instead of gentle showers continuing for a considerable length of time, we should have the most violent water-spouts, continuing only for a few minutes, or perhaps seconds, which, instead of refreshing the earth, would drown and lay waste every thing before them.

Since philosophers have admitted the electric fluid to such a large share in the operations of nature, almost all the natural phenomena have been accounted for by the action of that fluid; and rain, among others, has been reckoned an effect of electricity. But this word, unless it is explained, makes us no wiser than we were before; the phenomena of artificial electricity having been explained on principles which could scarce apply in any degree to the electricity of nature: and therefore all the solution we can obtain of the natural appearances of which we speak, comes to this, that rain is occasioned by a moderate electrification, hail and snow by one more violent, and thunder by the most violent of all; but in what manner this electrification is occasioned, hath not yet been explained. Throughout the various parts of this work where electricity hath been occasionally mentioned, the principles of artificial electricity ||, laid down in the treatise appropriated to that subject, have been applied to the solution of the phenomena of nature; those which are necessary to be attended to here are the following:

|| See *Electricity*, n^o 216, &c.

1. The electric fluid and solar light are the same substance in two different modifications.

2. Electricity is the motion of the fluid when running, or attempting to run, in a continued stream from one place to another: heat is when the fluid has no tendency but to vibrate outwards and inwards to and from a centre; or at least when its streams converge to a point or focus.

3. The fluid acting as electricity, like water, or any other fluid, always tends to the place where there is least resistance.

On these three principles may the phenomena of atmospheric electricity, and the descent of rain by its means, be explained as follows:

1. The light or heat of the sun, acting in that peculiar manner which we call *heat*, unites itself with the moisture of the earth, and forms it into vapour, which thus becomes specifically lighter than air, and of consequence ascends in the atmosphere to a certain height.

2. Besides the quantity of light which is thus united to the water, and forms it into vapour, a very considerable quantity enters the earth, where it assumes the nature of electric fluid.

3. As the earth is always full of that fluid, every quantity which enters must displace an equal quantity which is already there.

4. This quantity which is displaced must escape either at a distance from the place where the other enters, or very near it.

5. At whatever place a quantity of electric matter escapes, it must electrify the air above that place where it has escaped; and as a considerable quantity of light must always be reflected from the earth into the atmosphere, where it does not combine with the aqueous vapour, we have thence another source of electricity to the air; as this quantity must undoubtedly assume the action of electric fluid, especially after the action of the sun has ceased. Hence the reason

Rain.

Rain.

son why in serene weather the atmospheric electricity is always strongest, and rather more so in the night than in the day.

6. From these considerations, we see an evident reason why there must commonly be a difference between the electricity of the earth and that of the atmosphere, excepting when an earthquake is about to ensue. The consequence of this must be, that as the action of the solar light continues to bring down the electric matter, and the earth continues to discharge an equal quantity of it into the atmosphere, some part of the atmosphere must at last become overloaded with it, and attempt to throw it back into the earth. This attempt will be vain, until a vent is found for the electricity at some other place; and as soon as this happens, the electrified atmosphere begins to throw off its superfluous electricity, and the earth to receive it. As the atmosphere itself is a bad conductor, and the more so the drier it is, the electric matter attacks the small aqueous particles which are detained in it by means of the latent heat. These being unable to bear the impetus of the fluid, throw out their latent heat, which easily escapes, and thus makes a kind of vacuum in the electrified part of the atmosphere. The consequences of this are, that the aqueous particles being driven together in large quantity, at last become visible, and the sky is covered with clouds; at the same time a wind blows against these clouds, and, if there is no resistance in the atmosphere, will drive them away.

7. But if the atmosphere all round the cloud is exceedingly electrified, and the earth is in no condition to receive the superfluous fluid excepting in that place which is directly under the cloud, then the whole electricity of the atmosphere for a vast way round will tend to that part only, and the cloud will be electrified to an extreme degree. A wind will now blow against the cloud from all quarters, more and more of the vapour will be extricated from the air by the electric matter, and the cloud will become darker and thicker, at the same time that it is in a manner stationary, as being acted upon by opposite winds; though its size is enlarged with great rapidity by the continual supplies of vapour brought by the winds.

8. The vapours which were formerly suspended invisibly by means of the latent heat are now suspended visibly by the electric fluid, which will not let them fall to the earth, until it is in a condition to receive the electric matter descending with the rain.—It is easy to see, however, that thus every thing is prepared for a violent storm of thunder and lightning as well as rain. The surface of the earth becomes electrified from the atmosphere: but when this has continued for some time, a zone of earth considerably below the surface acquires an electricity opposite to that of the clouds and atmosphere; of consequence the electricity in the cloud being violently pressed on all sides, will at last burst out towards that zone where the resistance is least, as explained under the article LIGHTNING.—The vapours now having lost that which supported them, will fall down in rain, if there is not a sufficient quantity of electric matter to keep them in the same state in which they were before: but if this happens to be the case, the cloud will instantly be charged again, while little or no rain will fall; and hence very violent thunder sometimes takes place with-

out any rain at all, or such as is quite inconsiderable in quantity.

9. When the electricity is less violent, the rain will descend in vast quantity, especially after every flash of lightning; and great quantities of electric matter will thus be conveyed to the earth, inasmuch that sometimes the drops have been observed to shine as if they were on fire, which has given occasion to the reports of fiery rain having fallen on certain occasions. If the quantity of electric matter is smaller, so that the rain can convey it all gradually to the ground, there will be rain without any thunder; and the greater the quantity of electricity the more violent will be the rain.

From this account of the causes of rain, we may see the reason why in warm climates the rains are excessive, and for the most part accompanied with thunder; for there the electricity of the atmosphere is immensely greater than it is with us. We may also see why in certain places, according to the situation of mountains, seas, &c. the rains will be greater than in others, and likewise why some parts of the world are exempted from rain altogether; but as a particular discussion of these would necessarily include an explanation of the causes and phenomena of THUNDER, we shall for this reason refer the whole to be treated of under that article.

Whether this theory be just, however, it would be too assuming in us to say. It may admit of dispute, for we must grant that in the very best systems, though an occurrence so frequent, the theory of rain is but very imperfectly understood. Dr James Hutton, Fellow of the Royal Society of Edinburgh, whose speculations are always ingenious, though generally extraordinary, and much out of the common way, gives us a new theory of rain in the first volume of the Transactions of that society. It is well known that atmospheric air is capable of dissolving, with a certain degree of heat, a given quantity of water. The Doctor ascertains the ratio of the dissolving power of air, in relation to water, in different degrees of heat; and shows, that by mixing a portion of transparent humid warm air with a portion of cold air, the mixture becomes opaque, and part of the water will be precipitated; or, in other words, the vapour will be condensed into rain. The ratio which he states, however, does not appear to us to be supported by experience. Whether the electricity of the air changes in consequence of its depositing the water dissolved in it, or the change is a cause of this deposition, must remain uncertain; but, in either view, there must be an agent different from heat and cold, since the changes in these respects do not in other operations change the state of electricity. Dr Hutton supposes that heat and solution do not increase by equal increments; but that, in reality, if heat be supposed to increase by equal increments along a straight line, solution will be expressed by ordinates to a curve whose convex side is turned towards that line. That the power of solution is not increased in the same ratio with heat, is, however, hypothetical, except when we rise pretty high in the scale, when its proportional increase is a little doubtful; and it is not, in this paper, supported by experiment. The condensation of the breath in air is not an observation in point, except in air already saturated with vapour. It can amount, in any view, to no more than this, that to render it visible, the heat must be diminished.

Rain.

Rain.

minished in a greater proportion than can be compensated by the power of solution in the body of air, in which the portion expired is at first immersed. To explain rain from this cause, we must always suppose a constant diminution of heat to take place at the moment of the condensation of the vapour; but we actually find that the change from a state of vapour to the fluid state is attended with heat; so that rain must at once oppose its own cause, and continued rains would be impossible, without calling in the aid of other causes. From his own system, Dr Hutton endeavours to explain the regular and irregular seasons of rain, either respecting the generality of its appearance, or the regularity of its return. And to obviate the apparent exceptions of the theory, from the generality of rain, he explains the proportional quantities of rain, and adds a comparative estimate of climates, in relation to rain, with the meteorological observations made in our own climate. As his principle is at least insufficient, and we think erroneous, it would be useless, even were this a proper place for it, to pursue these various branches, which must partake of the errors of the system. In these branches we ought to observe, that there are several just observations, mixed with errors, because evaporation and condensation must at last be the great basis of every theory: the mistakes arise from not being aware of all the causes, and misrepresenting the operation of those which do exist.

In a work entitled *Thoughts on Meteorology*, Volume II. M. de Luc considers very particularly the grand phenomenon of rain, and the numerous circumstances connected with it. He examines the several hypotheses with considerable care; but thinks them, even if admissible, utterly insufficient to account for the formation of rain. The grand question in this inquiry is, What becomes of the water that rises in vapour into the atmosphere? or what state it subsists in there, between the time of its evaporation and its falling down again in rain? If it continues in the state of watery vapour, or such as is the immediate product of evaporation, it must possess the distinctive characters essential to that fluid: it must make the hygrometer move towards humidity, in proportion as the vapour is more or less abundant in the air: on a diminution of heat, the humidity, as shown by the hygrometer, must increase; and on an increase of the heat the humidity must diminish; and the introduction of other hygroscopic substances, drier than the air, must have the same effect as an augmentation of heat. These are the properties of watery vapour, on every hypothesis of evaporation; and therefore all the water that exists in the atmosphere without possessing these properties, is no longer vapour, but must have changed its nature. M. de Luc shows, that the water which forms rain, though it has ever been considered and reasoned upon as producing humidity, does not possess these properties, and must therefore have passed into another state. See a full account of his reasoning, and the steps by which he proceeded, in the article *METEOROLOGY*, n^o 7, &c. As he thinks that the vapour passes into an invisible state in the interval between evaporation and its falling again in rain, and that in that state it is not sensible to the hygrometer, he considers the laws of hygrometry as insufficient for explaining the formation of rain; but he does not pretend to have discovered the immediate cause of the for-

mation of clouds and rain. If it is not in the immediate product of evaporation that rain has its source; if the vapours change their nature in the atmosphere, so as no longer to be sensible to the hygrometer, or to the eye; if they do not become vapour again till clouds appear; and if, when the clouds are formed, no alteration is perceived in the quality of the air—we must acknowledge it to be very probable, that the intermediate state of vapour is no other than air—and that the clouds do not proceed from any distinct fluid contained in the atmosphere, but from a decomposition of a part of the air itself, perfectly similar to the rest.

It appears, to us at least, that M. de Luc's mode of reasoning on this subject agrees better with the phenomena than Dr Hutton's. The Doctor, however, thinks differently, and published answers to the objections of M. de Luc with regard to his theory of rain; to which M. de Luc replied in a letter which was printed in the Appendix to the 81st volume of the *Monthly Review*: but it would extend our article beyond its due bounds, to give a view of this controversy. See *VAPOUR, WATER, WEATHER, and WIND*.

As to the general quantity of rain that falls, and its proportion in several places at the same time, and in the same place at several times, we have many observations, journals, &c. in the *Memoirs of the French Academy*, the *Philosophical Transactions*, &c. Upon measuring, then, the rain falling yearly, its depth, at a medium, and its proportion in several places, is found as in the following table:

At Townley, in Lancashire, observed by Mr			Inches.
Townley	-	-	42 $\frac{1}{2}$
Upminster, in Essex, by Dr Derham	-	-	19 $\frac{1}{2}$
Zurich, in Switzerland, by Dr Scheuchzer	-	-	32 $\frac{1}{2}$
Pisa, in Italy, by Dr Mich. Ang. Tilli	-	-	43 $\frac{1}{2}$
Paris, in France, by M. de la Hire	-	-	19
Lisle, in Flanders, by M. de Vauban	-	-	24

At Upminster.			At Paris.		
1700	19	Inch. .03	21	Inch. .37	
1701	18	.69	27	.77	
1702	20	.38	17	.45	
1703	23	.99	18	.51	
1704	15	.80	21	.20	
1705	16	.93	14	.82	

From the *Meteorological Journal of the Royal Society*, kept by order of the president and council, it appears that the whole quantity of rain at London, in each of the years specified below, was as follows, viz.

			Inches.
1774	-	-	26 .328
1775	-	-	24 .883
1776	-	-	20 .354
1777	-	-	25 .371
1778	-	-	20 .772
1779	-	-	26 .785
1780	-	-	17 .313

The quantity of rain in the four following years at London was,

In			Inches.
1789	-	-	21 .976
1790	-	-	16 .052
1791	-	-	15 .310
1792	-	-	19 .489

Rain.

Rain.

Rain.

Proportion of the Rain of the several Seasons to one another.

1708	Depth at Pisa. Inch.	Depth at U. minf. Inch.	Depth at Zurich. Inch.	1708	Depth at Pisa. Inch.	Depth at U. minf. Inch.	Depth at Zurich. Inch.
Jan.	6 .41	2 .88	1 .64	July	0 .00	1 .11	3 .50
Feb.	3 .28	0 .46	1 .65	Aug.	2 .27	2 .94	3 .15
Mar.	2 .65	2 .03	1 .51	Sept.	7 .21	1 .46	3 .02
April	1 .25	0 .96	4 .69	Oct.	5 .33	0 .23	2 .44
May	3 .33	2 .02	1 .91	Nov.	0 .13	0 .86	0 .62
June	4 .90	2 .32	5 .91	Dec.	0 .00	1 .97	2 .62
Half Year	21 .82	10 .67	17 .31	Half Year	14 .94	8 .57	15 .35

See Philosophical Transactions abridged, vol. iv. p. ii. p. 81, &c. and also Meteorological Journal of the Royal Society, published annually in the Philosophical Transactions.

As to the use of rain, we may observe, that it moistens and softens the earth, and thus fits it for affording nourishment to plants; by falling on high mountains, it carries down with it many particles of loose earth, which serve to fertilize the surrounding valleys, and purifies the air from noxious exhalations, which tend in their return to the earth to meliorate the soil; it moderates the heat of the air; and is one means of supplying fountains and rivers. However, vehement rains in many countries are found to be attended with barrenness and poorness of the lands, and miscarriage of the crops in the succeeding year: and the reason is plain; for these excessive storms wash away the fine mould into the rivers, which carry it into the sea, and it is a long time before the land recovers itself again. The remedy to the famine, which some countries are subject to from this sort of mischief, is the planting large orchards and groves of such trees as bear esculent fruit; for it is an old observation, that in years, when grain succeeds worst, these trees produce most fruit of all. It may partly be owing to the thorough moistening of the earth, as deep as their roots go by these rains, and partly to their trunks stopping part of the light mould carried down by the rains, and by this means furnishing themselves with a coat of new earth.

Præternatural RAINS. We have numerous accounts, in the historians of our own as well as other countries, of præternatural rains; such as the raining of stones, of dust, of blood, nay, and of living animals, as young frogs, and the like. We are not to doubt the truth of what those who are authors of veracity and credit relate to us of this kind, so far as to suppose that the falling of stones and dust never happened; the whole mistake is, the supposing them to have fallen from the clouds: but as to the blood and frogs, it is very certain that they never fell at all, but the opinion has been a mere deception of the eyes. Men are extremely fond of the marvellous in their relations; but the judicious reader is to examine strictly whatever is reported of this kind, and is not to suffer himself to be deceived.

There are two natural methods by which quantities of stones and dust may fall in certain places, without their having been generated in the clouds or fallen as rain. The one is by means of hurricanes: the wind which we frequently see tearing off the tiles of houses, and carrying them to considerable distances, being equally able to take up a quantity of stones, and drop them again at some other place. But the other, which is much

the most powerful, and probably the most usual way, is for the eruptions of volcanoes and burning mountains to toss up, as they frequently do, a vast quantity of stones, ashes, and cinders, to an immense height in the air: and these, being hurried away by the hurricanes and impetuous winds which usually accompany those eruptions, and being in themselves much lighter than common stones, as being half calcined, may easily be thus carried to vast distances; and there falling in places where the inhabitants know nothing of the occasion, they cannot but be supposed by the vulgar to fall on them from the clouds. It is well known, that, in the great eruptions of *Ætna* and *Vesuvius*, showers of ashes, dust, and small cinders, have been seen to obscure the air, and overspread the surface of the sea for a great way, and cover the decks of ships; and this at such a distance, as it should appear scarce conceivable that they should have been carried to: and probably, if the accounts of all the showers of these substances mentioned by authors be collected, they will all be found to have fallen within such distances of volcanoes; and if compared as to the time of their falling, will be found to correspond in that also with the eruptions of those mountains. We have known instances of the ashes from *Vesuvius* having been carried thirty, nay, forty leagues, and peculiar accidents may have carried them yet farther. It is not to be supposed that these showers of stones and dust fall for a continuance in the manner of showers of rain, or that the fragments or pieces are as frequent as drops of water; it is sufficient that a number of stones, or a quantity of dust, fall at once on a place, where the inhabitants can have no knowledge of the part from whence they came, and the vulgar will not doubt their dropping from the clouds. Nay, in the canton of *Berne* in Switzerland, the inhabitants accounted it a miracle that it rained earth and sulphur upon them at a time that a small volcano terrified them; and even while the wind was so boisterous, and hurricanes so frequent, that they saw almost every moment the dust, sand, and little stones torn up from the surface of the earth in whirlwinds, and carried to a considerable height in the air, they never considered that both the sulphur thrown up by the volcano, and the dust, &c. carried from their feet must fall soon after somewhere. It is very certain that in some of the terrible storms of large hail, where the hail-stones have been of many inches round, on breaking them there have been found what people have called *stones in their middle*; but these observers needed only to have waited the dissolving of one of these hail-stones, to have seen the stone in its centre disunited also, it being only formed of the particles of loose earthy matter, which the water, exhaled by the sun's heat, had taken up in extremely small molecules with it; and this only having served to give an opaque hue to the inner part of the congelation, to which the freezing of the water alone gave the apparent hardness of stone.

The raining of *blood* has been ever accounted a more terrible sight and a more fatal omen than the other præternatural rains already mentioned. It is very certain that nature forms blood nowhere but in the vessels of animals; and therefore showers of it from the clouds are by no means to be credited. Those who suppose that what has been taken for blood has been actually seen falling through the air, have had recourse to flying insects for its origin, and suppose it the eggs or dung of certain

Rain. certain butterflies discharged from them as they were high up in the air. But it seems a very wild conjecture, as we know of no butterfly whose excrements or eggs are of such a colour, or whose abode is so high, or their flocks so numerous, as to be the occasion of this.

It is most probable that these bloody waters were never seen falling; but that people seeing the standing waters blood-coloured, were assured, from their not knowing how it should else happen, that it had rained blood into them. A very memorable instance of this there was at the Hague in the year 1670. Swammerdam, who relates it, tells us, that one morning the whole town was in an uproar on finding their lakes and ditches full of blood, as they thought; and having been certainly full of water the night before, they agreed it must have rained blood in the night: but a certain physician went down to one of the canals, and taking home a quantity of this blood-coloured water, he examined it by the microscope, and found that the water was water still, and had not at all changed its colour; but that it was full of prodigious swarms of small red animals, all alive, and very nimble in their motions, whose colour and prodigious number gave a red tinge to the whole body of the water they lived in, on a less accurate inspection. The certainty that this was the case, did not however persuade the Hollanders to part with the miracle: they prudently concluded, that the sudden appearance of such a number of animals was as great a prodigy as the raining of blood would have been; and are assured to this day, that this portent foretold the scene of war and destruction which Louis XIV. afterwards brought into that country, which had before enjoyed 40 years uninterrupted peace.

The animals which thus colour the water of lakes and ponds are the *pulices arborescentes* of Swammerdam, or the water-fleas with branched horns. These creatures are of a reddish-yellow or flame colour: they live about the sides of ditches, under weeds, and among the mud; and are therefore the less visible, except at a certain time, which is in the end or beginning of June: it is at this time that these little animals leave their recesses to float loose about the water, to meet for the propagation of their species, and by that means become visible in the colour they give the water. This is visible, more or less, in one part or other of almost all standing waters at this season; and it is always at this season that the bloody waters have alarmed the ignorant. See *PuLEX Monoculus*.

The raining of frogs is a thing not less wonderful in the accounts of authors who love the marvellous, than those of blood or stones; and this is supposed to happen so often, that there are multitudes who pretend to have been eye-witnesses of it. These rains of frogs always happen after very dry seasons, and are much more frequent in the hotter countries than in the cold ones. In Italy they are very frequent; and it is not uncommon to see the streets of Rome swarming both with young frogs and toads in an instant in a shower of rain; they hopping everywhere between the people's legs as they walk, though there was not the least appearance of them before. Nay, they have been seen to fall through the air down upon the pavements. This seems a strong circumstance in favour of their being rained down from the clouds; but, when strictly examined, it comes to nothing: for these frogs that are seen to fall, are always

found dead, lamed, or bruised by the fall, and never hop about as the rest; and they are never seen to fall, except close under the walls of houses, from the roofs and gutter of which they have accidentally slipped down. Some people, who love to add to strange things yet stranger, affirm that they have had the young frogs fall into their hats in the midst of an open field; but this is idle, and wholly false.

Others, who cannot agree to their falling from the clouds, have tried to solve the difficulty of their sudden appearance, by supposing them hatched out of the egg, or spawn, by these rains. Nay, some have supposed them made immediately out of the dust: but there are unanswerable arguments against all these suppositions. Equivocal generation, or the spontaneous production of animals out of dust, is now wholly exploded. The fall from the clouds must destroy and kill these tender and soft-bodied animals: and they cannot be at this time hatched immediately out of eggs; because the young frog does not make its appearance from the egg in form, but has its hinder legs enveloped in a skin, and is what we call a *tadpole*; and the young frogs are at least 100 times larger at the time of their appearance, than the egg from which they should be hatched.

It is beyond a doubt, that the frogs which make their appearance at this time, were hatched and in being long before: but that the dry seasons had injured them, and kept them sluggishly in holes or coverts; and that all the rain does, is the enlivening them, giving them new spirits, and calling them forth to seek new habitations, and enjoy the element they were destined in great part to live in. Theophrastus, the greatest of all the naturalists of antiquity, has affirmed the same thing. We find that the error of supposing these creatures to fall from the clouds was as early as that author's time; and also that the truth, in regard to their appearance, was as early known; though, in the ages since, authors have taken care to conceal the truth, and to hand down to us the error. We find this venerable sage, in a fragment of his on the generation of animals which appear on a sudden, bantering the opinion, and asserting that they were hatched and living long before. The world owes, however, to the accurate Signior Redi the great proof of this truth, which Theophrastus only has affirmed: for this gentleman, dissecting some of these new-appearing frogs, found in their stomachs herbs and other half-digested food; and, openly showing this to his credulous countrymen, asked them whether they thought that nature, which engendered, according to their opinion, these animals in the clouds, had also been so provident as to engender grubs there for their food and nourishment?

To the raining of frogs we ought to add the raining of *grasshoppers* and *locusts*, which have sometimes appeared in prodigious numbers, and devoured the fruits of the earth. There has not been the least pretence for the supposing that these animals descended from the clouds, but that they appeared on a sudden in prodigious numbers. The naturalist, who knows the many accidents attending the eggs of these and other the like animals, cannot but know that some seasons will prove particularly favourable to the hatching them, and the prodigious number of eggs that many insects lay could not but every year bring us such abundance of the young, were they not liable to many accidents, and had not provident nature taken care, as in many plants, to continue the

Rain.

Rain.

the species by a very numerous stock of seeds, of which perhaps not one in 500 need take root in order to continue an equal number of plants. As it is thus also in regard to insects, it cannot but happen, that if a favourable season encourage the hatching of all those eggs, a very small number of which alone were necessary to continue the species, we must, in such seasons, have a proportionate abundance of them. There appeared about 50 years ago, in London, such a prodigious swarm of the little beetle we call the *lady-cow*, that the very posts in the streets were everywhere covered with them. But thanks to the progress of philosophy among us, we had no body to assert that it rained cow-ladies, but contented ourselves with saying that it had been a favourable season for their eggs. The prodigious number of a sort of grub which did vast mischief about the same period among the corn and grass by eating off their roots, might also have been supposed to proceed from its having rained grubs by people fond of making every thing a prodigy; but our knowledge in natural history assured us, that these were only the hexapode worms of the common hedge-beetle called the *cock-chaffer*.

The raining of *fishes* has been a prodigy also much talked of in France, where the streets of a town at some distance from Paris, after a terrible hurricane in the night, which tore up trees, blew down houses, &c. were found in a manner covered with fishes of various sizes. Nobody here made any doubt of these having fallen from the clouds; nor did the absurdity of fish, of five or six inches long, being generated in the air, at all startle the people, or shake their belief in the miracle, till they found, upon inquiry, that a very well-stocked fish-pond, which stood on an eminence in the neighbourhood, had been blown dry by the hurricane, and only the great fish left at the bottom of it, all the smaller fry having been tossed into their streets.

Upon the whole, all the supposed marvellous rains have been owing to substances naturally produced on the earth, and either never having been in the air at all, or only carried thither by accident.

In Silesia, after a great dearth of wheat in that country, there happened a violent storm of wind and rain, and the earth was afterwards covered, in many places, with small round seeds. The vulgar cried out that Providence had sent them food, and that it had rained *millets*: but these were, in reality, only the seeds of a species of veronica, or speed-well, very common in that country; and whose seeds being just ripe at that time, the wind had dislodged them from their capsules, and scattered them about. In our own country, we have histories of rains of this marvellous kind, but all fabulous. It was once said to rain *wheat* in Wiltshire; and the people were all alarmed at it as a miracle, till Mr Cole showed them, that what they took for wheat was only the seeds or kernels of the berries of ivy, which being then fully ripe, the wind had dislodged from the sides of houses, and trunks of trees, on which the ivy that produced them crept.

And we even once had a raining of fishes near the coast of Kent in a terrible hurricane, with thunder and lightning. The people who saw small sprats strewn all about afterwards, would have it that they had fallen from the clouds; but those who considered how far the high winds have been known to carry the sea-water, did

not wonder that they should be able to carry small fish with it so small a part of the way.

In the Philosophical Transactions for 1782 we have the following account of a preternatural kind of rain by Count de Gioeni: "The morning of the 24th instant there appeared here a most singular phenomenon. Every place exposed to the air was found wet with a coloured cretaceous grey water, which, after evaporating and filtrating away, left every place covered with it to the height of two or three lines; and all the iron-work that was touched by it became rusty.

"The public, inclined to the marvellous, fancied various causes of this rain, and began to fear for the animals and vegetables.

"In places where rain-water was used, they abstained from it: some suspecting vitriolic principles to be mixed with it, and others predicting some epidemical disorder.

"Those who had observed the explosions of Etna 20 days and more before, were inclined to believe it originated from one of them.

"The shower extended from N. $\frac{1}{4}$ N.E. to S. $\frac{1}{4}$ S.W. over the fields, about 70 miles in a right line from the vertex of Etna.

"There is nothing new in volcanos having thrown up sand, and also stones, by the violent expansive force generated within them, which sand has been carried by the wind to distant regions.

"But the colour and subtilty of the matter occasioned doubts concerning its origin; which increased from the remarkable circumstance of the water in which it came incorporated; for which reasons some other principle or origin was suspected.

"It became, therefore, necessary by all means to ascertain the nature of this matter, in order to be convinced of its origin, and of the effects it might produce. This could not be done without the help of a chemical analysis. To do this then with certainty, I endeavoured to collect this rain from places where it was most probable no heterogeneous matter would be mixed with it. I therefore chose the plant called *brassica capitata*, which having large and turned-up leaves, they contained enough of this coloured water: many of these I emptied into a vessel, and left the contents to settle till the water became clear.

"This being separated into another vessel, I tried it with vegetable alkaline liquors and mineral acids; but could observe no decomposition by either. I then evaporated the water in order to reunite the substances that might be in solution; and touching it again with the aforesaid liquors, it showed a slight effervescence with the acids. When tried with the syrup of violets, this became a pale green; so that I was persuaded it contained a calcareous salt. With the decoction of galls no precipitation was produced.

"The matter being afterwards dried in the shade, it appeared a very subtil fine earth, of a cretaceous colour, but inert, from having been diluted by the rain.

"I next thought of calcining it with a slow fire, and it assumed the colour of a brick. A portion of this being put into a crucible, I applied to it a stronger heat; by which it lost almost all its acquired colour. Again, I exposed a portion of this for a longer time to a very violent heat (from which a vitrification might be expected);

Rain.

Rain,
Rainbow.

expected); it remained, however, quite soft, and was easily bruised, but returned to its original dusky colour.

"From the most accurate observations of the smoke from the three calcinations, I could not discover either colour or smell that indicated any arsenical or sulphureous mixture.

"Having therefore calcined this matter in three portions, with three different degrees of fire, I presented a good magnet to each: it did not act either on the first or second; a slight attraction was visible in many places on the third: this persuaded me, that this earth contains a martial principle in a metallic form, and not in a vitriolic substance.

"The nature of these substances then being discovered, their volcanic origin appears; for iron, the more it is exposed to violent calcination, the more it is divided by the loss of its phlogistic principle; which cannot naturally happen but in the great chimney of a volcano. Calcareous salt, being a marine salt combined with a calcareous substance by means of violent heat, cannot be otherwise composed than in a volcano.

"As to their dreaded effects on animals and vegetables, every one knows the advantageous use, in medicine, both of the one and the other, and this in the same form as they are thus prepared in the great laboratory of nature.

"Vegetables, even in flower, do not appear in the least macerated, which has formerly happened from only showers of sand.

"How this volcanic production came to be mixed with water may be conceived in various ways.

"Ætna, about its middle regions, is generally surrounded with clouds that do not always rise above its summit, which is 2900 paces above the level of the sea. This matter being thrown out, and descending upon the clouds below it, may happen to mix and fall in rain with them in the usual way. It may also be conjectured, that the thick smoke which the volcanic matter contained might, by its rarefaction, be carried in the atmosphere by the winds over that tract of country; and then cooling so as to condense and become specifically heavier than the air, might descend in that coloured rain.

"I must, however, leave to philosophers (to whom the knowledge of natural agents belongs) the examination and explanation of such phenomena, confining myself to observation and chemical experiments."

RAIN, a well built and fortified town of Bavaria, one of the keys of this electorate, on the Lech, 20 miles west of Ingolstadt. N. Lat. 48. 51. E. Long. 11. 12.

RAIN-Bird. See CUCULUS, no 8.

RAINBOW. See OPTICS, Part II. Sect. i. § 1.

In the Philosophical Transactions for 1793, we have the following account of two rainbows seen by the Rev. Mr Sturges.

"On the evening of the 9th of July 1792, between seven and eight o'clock, at Alverstoke, near Gosport, on the sea-coast of Hampshire, there came up, in the south-east, a cloud with a thunder-shower; while the sun shone bright, low in the horizon to the north-west.

Plate
ccccxvii.
fig. 2. "In this shower two primary rainbows appeared, AB and AC, not concentric, but touching each other
VOL. XV. Part II.

Rainbow.

at A, in the fourth part of the horizon; with a secondary bow to each, DE and DF (the last very faint, but discernible), which touched likewise at D. Both the primary were very vivid for a considerable time, and at different times nearly equally so; but the bow AB was most permanent, was a larger segment of a circle, and at last, after the other had vanished, became almost a semi-circle; the sun being near setting. It was a perfect calm, and the sea was as smooth as glass.

"If I might venture to offer a solution of this appearance, it would be as follows. I consider the bow AB as the true one, produced by the sun itself; and the other, AC, as produced by the reflection of the sun from the sea, which, in its perfectly smooth state, acted as a speculum. The direction of the sea, between the Isle of Wight and the land, was to the north-west in a line with the sun, as it was then situated. The image reflected from the water, having its rays issuing from a point lower than the real sun, and in a line coming from beneath the horizon, would consequently form a bow higher than the true one AB. And the shores, by which that narrow part of the sea is bounded, would before the sun's actual setting intercept its rays from the surface of the water, and cause the bow AC, which I suppose to be produced by the reflection, to disappear before the other."

The marine or sea bow is a phenomenon which may be frequently observed in a much agitated sea, and is occasioned by the wind sweeping part of the waves, and carrying them aloft; which when they fall down are refracted by the sun's rays, which paint the colours of the bow just as in a common shower. These bows are often seen when a vessel is sailing with considerable force, and dashing the waves around her, which are raised partly by the action of the ship and partly by the force of the wind, and, falling down, they form a rainbow; and they are also often occasioned by the dashing of the waves against the rocks on shore.

In the Philosophical Transactions, it is observed by F. Bourzes, that the colours of the marine rainbow are less lively, less distinct, and of shorter continuance, than those of the common bow; that there are scarce above two colours distinguishable, a dark yellow on the side next the sun, and a pale green on the opposite side. But they are more numerous, there being sometimes 20 or 30 seen together.

To this class of bows may be referred a kind of white or colourless rainbows, which Mentzelius and others affirm to have been at noon-day. M. Marlotte, in his fourth *Essai de Physique*, says, these bows are formed in mists, as the others are in showers; and adds, that he has seen several both after sun-rising and in the night. The want of colours he attributes to the smallness of the vapours which compose the mist; but perhaps it is rather from the exceeding tenuity of the little vesicule of the vapour, which being only little watery pellicles bloated with air, the rays of light undergo but little refraction in passing out of air into them; too little to separate the differently coloured rays, &c. Hence the rays are reflected from them, compounded as they came, that is, white. Robault mentions * coloured rainbows on the grass; formed by the refractions of the sun's rays in the morning dew. Rainbows have been also produced by the reflection of the sun from a river; and in the Philosophical Transactions, Vol. I. p. 294. we

* *Trait. de Physique.*

Rainbow. Have an account of a rainbow, which must have been formed by the exhalations from the city of London, when the sun had been set 20 minutes, and consequently the centre of the bow was above the horizon. The colours were the same as in the common rainbow, but fainter.

It has often been made a subject of inquiry among the curious how there came to be no rainbow before the flood, which is thought by some to have been the case from its being made a sign of the covenant which the Deity was pleased to make with man after that event. Mr Whitehurst, in his *Inquiry into the Original State and Formation of the Earth*, p. 173, &c. endeavours to establish it as a matter of great probability at least, that the antediluvian atmosphere was so uniformly temperate as never to be subject to storms, tempests, or rain, and of course it could never exhibit a rainbow. For our own part, we cannot see how the earth at that period could do without rain any more than at present; and it appears to us from Scripture equally probable that the rainbow was seen before the flood as after it. It was then, however, made a token of a certain covenant; and it would unquestionably do equally well for that purpose if it had existed before as if it had not.

Lunar RAINBOW. The moon sometimes also exhibits the phenomenon of an iris or rainbow by the refraction of her rays in drops of rain in the night-time. This phenomenon is very rare. In the *Philosophical Transactions* for 1783, however, we have an account of three seen in one year, and all in the same place, communicated in two letters by Marmaduke Tunstall, Esq. The first was seen 27th February 1782, at Greta Bridge, Yorkshire, between seven and eight at night, and appeared "in tolerably distinct colours, similar to a solar one, but more faint: the orange colour seemed to predominate. It happened at full moon; at which time alone they are said to have been always seen. Though Aristotle is said to have observed two, and some others have been seen by Suellius, &c. I can only find two described with any accuracy; viz. one by Plot, in his History of Oxfordshire, seen by him in 1675, though without colours; the other seen by a Derbyshire gentleman at Glapwell, near Chesterfield, described by Thoresby, and inserted in N^o 331. of the *Philosophical Transactions*: this was about Christmas, 1710, and said to have had all the colours of the Iris Solaris. The night was windy; and though there was then a drizzling rain and dark cloud, in which the rainbow was reflected, it proved afterwards a light frost."

Two others were afterwards seen by Mr Tunstall; one on July the 30th, about 11 o'clock, which lasted about a quarter of an hour, without colours. The other, which appeared on Friday October 18. was "perhaps the most extraordinary one of the kind ever seen. It was first visible about nine o'clock, and continued, tho' with very different degrees of brilliancy, till past two. At first, though a strongly marked bow, it was without colours; but afterwards they were very conspicuous and vivid in the same form as in the solar, though fainter; the red, green, and purple, were most distinguishable. About twelve it was the most splendid in appearance; its arc was considerably a smaller segment of a circle than a solar; its south-east limb first began to fail, and a considerable time before its final extinction: the wind was very high, nearly due west, most part of

the time, accompanied with a drizzling rain. It is a singular circumstance, that three of these phenomena should have been seen in so short a time in one place, as they have been esteemed ever since the time of Aristotle, who is said to have been the first observer of them, and saw only two in 50 years, and since by Plot and Thoresby, almost the only two English authors who have spoke of them, to be exceeding rare. They seem evidently to be occasioned by a refraction in a cloud or turbid atmosphere, and in general are indications of stormy and rainy weather: so bad a season as the late summer having, I believe, seldom occurred in England. Thoresby, indeed, says, the one he observed was succeeded by several days of fine serene weather. One particular, rather singular, in the second, viz. of July the 30th, was its being six days after the full of the moon; and the last, though of so long a duration, was three days before the full: that of the 27th of February was exactly at the full, which used to be judged the only time they could be seen, though in the *Encyclopedia* there is an account that Weidler observed one in 1719, in the first quarter of the moon, with faint colours, and in very calm weather. No lunar iris, I ever heard or read of, lasted near so long as that on the 18th instant, either with or without colours."

In the *Gentleman's Magazine* for August 1788 we have an account of a lunar rainbow by a correspondent who saw it. "On Sunday evening the 17th of August (says he), after two days, on both of which, particularly the former, there had been a great deal of rain, together with lightning and thunder, just as the clocks were striking nine, 23 hours after full moon, looking through my window, I was struck with the appearance of something in the sky, which seemed like a rainbow. Having never seen a rainbow by night, I thought it a very extraordinary phenomenon, and hastened to a place where there were no buildings to obstruct my view of the hemisphere: here I found that the phenomenon was no other than a lunar rainbow; the moon was truly 'walking in brightness,' brilliant as she could be; not a cloud was to be seen near her; and over-against her, toward the north-west, or perhaps rather more to the north, was a rainbow, a vast arch, perfect in all its parts, not interrupted or broken as rainbows frequently are, but unremittedly visible from one horizon to the other. In order to give some idea of its extent, it is necessary to say, that as I stood toward the western extremity of the parish of Stoke Newington, it seemed to take its rise from the west of Hampstead, and to the end, perhaps, in the river Lea, the eastern boundary of Tottenham; its colour was white, cloudy, or greyish, but a part of its western leg seemed to exhibit tints of a faint sickly green. I continued viewing it for some time, till it began to rain; and at length the rain increasing, and the sky growing more hazy, I returned home about a quarter or 20 minutes past nine, and in ten minutes came out again; but by that time all was over, the moon was darkened by clouds, and the rainbow of course vanished."

Marine RAINBOW, or Sea-bow. See the article RAINBOW.

RAINBOW-Stone. See MOON-Stone.

RAISINS, grapes prepared by suffering them to remain on the vine till they are perfectly ripe, and then drying them in the sun, or by the heat of an oven.

The

Raisin
||
Raleigh.

The difference between raisins dried in the sun and those dried in ovens, is very obvious: the former are sweet and pleasant, but the latter have a latent acidity with the sweetness that renders them much less agreeable.

The common way of drying grapes for raisins, is to tie two or three bunches of them together while yet on the vine, and dip them into a hot lixivium of wood-ashes, with a little of the oil of olives in it. This disposes them to shrink and wrinkle; and after this they are left on the vine three or four days separated on sticks in an horizontal situation, and then dried in the sun at leisure, after being cut from the tree. The finest and best raisins are those called in some places *Damascus* and *Jube raisins*; which are distinguished from the others by their size and figure: they are flat and wrinkled on the surface, soft and juicy within, and near an inch long; and, when fresh and growing on the bunch, are of the size and shape of a large olive.

The raisins of the sun, and jar-raisins, are all dried by the heat of the sun; and these are the sorts used in medicine. However, all the kinds have much the same virtues: they are all nutritive and balsamic; they are allowed to be attenuant, are said to be good in nephritic complaints, and are an ingredient in pectoral decoctions: in which cases, as also in all others where astringency is not required of them, they should have the stones carefully taken out.

RAISIN-Wine. See WINE.

RAKKATH (anc. geog.), a town of Upper Galilee, thought to be Tiberias, (Tahnud): but this is denied by Reland, who says that Rakkath was a town of the tribe of Naphtali.

RAKE is a well known instrument with teeth, by which the ground is divided. See AGRICULTURE, p. 318.

RAKE also means a loose, disorderly, vicious, and thoughtless fellow.

RAKE of a Ship, is all that part of her hull which hangs over both ends of her keel. That which is before is called the *fore rake*, or *rake forward*, and that part which is at the setting on of the stern-post is called the *rake-aft*, or *afterward*.

RALEIGH (Sir Walter), fourth son of Walter Raleigh, Esq; of Fardel, in the parish of Cornwood in Devonshire, was born in 1552 at Hayes, in the parish of Budley, a farm belonging to his father. About the year 1568, he was sent to Oriel college in Oxford, where he continued but a short time; for in the following year he embarked for France, being one of the hundred volunteers, commanded by Henry Champernon, who, with other English troops, were sent by queen Elizabeth to assist the queen of Navarre in defending the Protestants. In this service he continued for five or six years; after which he returned to London, and probably resided in the Middle Temple. But his enterprising genius would not suffer him to remain long in a state of inactivity. In 1577 or 1578, he embarked for the Low Countries with the troops sent by the queen to assist the Dutch against the Spaniards, and probably shared the glory of the decisive victory over Don John of Austria in 1578. On his return to England, a new enterprise engaged his attention. His half-brother, Sir Humphrey Gilbert, having obtained a patent to plant and inhabit some parts of North Ame-

rica, Mr Raleigh embarked in this adventure; but, meeting with a Spanish fleet, after a smart engagement they returned, without success, in 1579.

The following year, the king of Spain, in conjunction with the pope, having projected a total conquest of the English dominions, sent troops to Ireland to assist the Desmond's in the Munster rebellion. Raleigh obtained a captain's commission under Lord Grey of Wilton, then deputy of Ireland, and embarked for that kingdom; where, by his conduct and resolution, he was principally instrumental in putting an end to the rebellions attempt. He returned to England; and attracted the notice of queen Elizabeth, owing, as we are told in Naunton's *Fragmenta Regalia*, to the following accidental piece of gallantry. The queen, as she was one day taking a walk, being stopped by a *plashy* place in the road, our gallant young soldier took off his new plush mantle, and spread it on the ground. Her majesty trod gently over the fair foot-cloth, surprised and pleased with the adventure. He was a handsome man, and remarkable for his gentility of address.

The queen admitted him to her court, and employed him first as an attendant on the French ambassador Simier on his return home, and afterward to escort the duke of Anjou to Antwerp. During this excursion he became personally known to the prince of Orange; from whom, at his return, he brought special acknowledgments to the queen, who now frequently conversed with him. But the inactive life of a courtier did not suit the enterprising spirit of Mr Raleigh. In the year 1583, he embarked with his brother, Sir Humphrey Gilbert, on a second expedition to Newfoundland, in a ship called the *Raleigh*, which he built at his own expence; but was obliged to return on account of an infectious distemper on board. He was, however, little affected by this disappointment, that he now laid before the queen and council a proposal for exploring the continent of North America; and in 1584 obtained a patent empowering him to possess such countries as he should discover in that part of the globe. Accordingly Mr Raleigh fitted out two ships at his own expence, which sailed in the month of April, and returned to England about the middle of September, reporting that they had discovered and taken possession of a fine country called *Windangocoo*, to which the queen gave the name of *Virginia*. About this time he was elected knight of the shire for the county of Devon, and soon after received the honour of knighthood; and to enable him to carry on his designs abroad, the queen granted him a patent for licensing the venders of wine throughout the kingdom. In 1585 he sent a fleet of seven ships to Virginia, commanded by his relation Sir Richard Greenville, who left a colony at Roanah of 107 persons, under the government of Mr Lane; and by the establishment of this colony he first imported tobacco into England. See NICOTIANA. In the same year Sir Walter Raleigh obtained a grant of 12,000 acres of the forfeited lands in the county of Corke in Ireland.—About the same time he was made seneschal of the duchy of Cornwall, and warden of the flanneries; and grew into such favour with the queen, that even Leicester was jealous of his influence.

In 1587, he sent another colony of 150 men to Virginia, with a governor, Mr John White, and 12 assistants. About this time we find our knight distinguish-

Raleigh ed by the titles of *Captain of the queen's guards*, and *Lieutenant general of Cornwall*. From this period to the year 1594, he was continually engaged in projecting new expeditions, sending succours to colonies abroad, defending the kingdom from the insults of the Spaniards, and transacting parliamentary business, with equal ability and resolution. Whilst thus employed, he was publicly charged, in a libel written by the infamous Jesuit Parsons, with being an Atheist; a groundless and ridiculous imputation. In 1594, he obtained from the queen a grant of the manor of Sherborne in Dorsetshire, where he built a magnificent house: but Sir Walter fell under the queen's displeasure on account of an intrigue with the daughter of Sir Nicholas Throgmorton, one of the maids of honour; however, he married the lady, and lived with her in great conjugal harmony. During his disgrace at court, he projected the conquest of Guiana in South America, and in 1595 sailed for that country; of which having taken possession, after defeating the Spaniards who were settled there, he returned to England the same year, and soon after published an account of his expedition. In the following year he was one of the admirals in the successful expedition against Cadiz, under the command of Howard and the earl of Essex; and in 1597 he sailed with the same commanders against the Azores. Soon after these expeditions, we find him assiduously engaged in parliamentary business, and a distinguished personage in jousts and tournaments. In 1600 he was sent on a joint embassy with Lord Cobham to Flanders, and at his return made governor of Jersey.

Queen Elizabeth died in the beginning of the year 1603; and with her Raleigh's glory and felicity sunk, never to rise again. Upon the accession of James, Sir Walter lost his interest at court, was stripped of his preferments, and accused of a plot against the king. He was arraigned at Winchester, and, on his trial, insulted by the most shocking brutality by the famous Coke, attorney-general, whose sophistical vociferation influenced the jury to convict him without the least proof of guilt. After a month's imprisonment, however, in daily expectation of his execution, he was reprieved, and sent to the Tower; and his estates were given to Car, earl of Somerset, the king's favourite. During this confinement, he wrote many of his most valuable pieces, particularly his *History of the World*. In March 1615, after 16 years imprisonment, he obtained his liberty, and immediately began to prepare for another voyage to Guiana. In August 1616, the king granted him a very ample commission for that purpose; and in July the year following, he sailed from Plymouth: but, strange as it may appear, it is most certain that the whole scheme was revealed to the Spaniards by the king himself, and thus necessarily rendered abortive.

He returned to England in 1618, where he was soon after seized, imprisoned, and beheaded; not for any pretended misdemeanor on the late expedition, but in consequence of his former attainder. The truth of the matter is, he was sacrificed by the pusillanimous monarch to appease the Spaniards; who, whilst Raleigh lived, thought every part of their dominions in danger. He was executed in Old Palace Yard, and buried in St Margaret's adjoining, in the 66th year of his age. His behaviour on the scaffold was manly, unaffected, cheerful, and easy. Being asked by the executioner which way he would lay his head, he answered, "So the heart

be right, it is no matter which way the head lies." He was a man of admirable parts, extensive knowledge, undaunted resolution, and strict honour and honesty. He was the author of a great many works, some of which have not been printed.

RALLUS, the RAIL, in ornithology; a genus belonging to the order of gralke. The beak is thickest at the base, compressed, equal, acute, and somewhat sharp on the back near the point; the nostrils are oval; the feet have four toes, without any web; and the body is compressed. Mr Latham, in his *Index Ornithologicus*, enumerates 24 species, besides some varieties. They are chiefly distinguished by their colour. "These birds (says Buffon) constitute a large family, and their habits are different from those of the other shore-birds, which reside on sands and gravel. The rails, on the contrary, inhabit only the slimy margins of pools and rivers, especially low grounds covered with flags and other large marsh plants. This mode of living is habitual and common to all the species of water-rails. The land rail frequents meadows, and from the disagreeable cry, or rather rattling in the throat of this bird, is derived the generic name. In all the rails, the body is slender, and shrunk at the sides; the tail extremely short; the head small; the bill pretty like that of the gallinaceous kind, though much longer, and not so thick; a portion of the leg above the knee is bare; the three fore-toes without membranes, and very long: they do not, like other birds, draw their feet under their belly in flying, but allow them to hang down: their wings are small and very concave, and their flight is short.—They seem to be more diffused than varied; and nature has produced or transported them over the most distant lands. Captain Cook found them at the Straits of Magellan; in different islands of the southern hemisphere, at Ananoka, at Tanna, and at the isle of Norfolk. In the Society Islands there are two species of rails; a little black spotted one, (*pooa-née*), and a little red-eyed one (*mai-bo*). It appears that the two acolins of Fernandez, which he denominates *water-quails*, are of a species of rails peculiar to the great lake of Mexico.—The colins, which might be confounded with these, are a kind of partridges." The principal are,

1. The aquaticus, or water-rail, is a bird of a long slender body, with short concave wings. It delights less in flying than running: which it does very swiftly along the edges of brooks covered with bushes: as it runs, it every now and then flirts up its tail, and in flying hangs down its legs; actions it has in common with the water-hen. Its weight is four ounces and a half. The length to the end of the tail is 12 inches; the breadth 16. The bill is slender, slightly incurvated, one inch three quarters long: the upper mandible black, edged with red; the lower, orange-coloured: the head, hind part of the neck, the back, and coverts of the wings and tail, are black, edged with an olive brown; the throat, breast, and upper part of the belly, are ash-coloured: the sides under the wings as far as the rump, finely varied with black and white bars. The tail is very short, consists of 12 black feathers; the ends of the two middle tipped with rust colour; the feathers immediately beneath the tail white. The legs are placed far behind, and are of a dusky flesh-colour. The toes very long, and divided to their very origin; though the feet are not webbed, it takes the water; will swim on it with much ease, but is often observed

Rallus.

to run along the surface. "Water rails (says Buffon) are seen near the perennial fountains during the greatest part of the winter, yet like the land rails they have their regular migrations. They pass Malta in the spring and autumn. The Viscount de Querhoent saw some 50 leagues off the coasts of Portugal on the 17th of April. They were so fatigued, that they suffered themselves to be caught by the hand (A). Gmelin found these birds in the countries watered by the Don. Belon calls them *black rails*, and says they are everywhere known, and that the species is more numerous than the red rail, or land rail. The flesh of the water rail is not so delicate as that of the land rail, and has even a marshy taste, nearly like that of the gallinule. It continues the whole year in England."

2. The porzana, or gallinule, is not very frequent in Great Britain, and is said to be migratory. Inhabits the sides of small streams, concealing itself among the bushes. Its length is nine inches; its breadth, 15; its weight, four ounces five drachms. The head is brown, spotted with black; the neck a deep olive, spotted with white: the feathers of the back are black next their shafts, then olive-coloured, and edged with white; the scapulars are olive, finely marked with two small white spots on each web: the legs of a yellowish green. "Its habits (says Buffon) wild, its instinct stupid, the porzana is unsusceptible of education, nor is even capable of being tamed. We raised one, however, which lived a whole summer on crumbs of bread and hemp-seed; when by itself, it kept constantly in a large bowl of water; but if a person entered the closet where it was shut, it ran to conceal itself in a small dark corner, without venting cries or murmurs. In the state of liberty, however, it has a sharp piercing voice, much like the scream of a young bird of prey; and though it has no propensity to society, as soon as one cries, another repeats the sound, which is thus conveyed through all the rest in the district. Like all the rails, it is so obstinately averse to rise, that the sportsman often seizes it with his hand, or fells it with a stick. If it finds a bush in its retreat, it climbs upon it, and from the top of its asylum beholds the dogs brushing along in fault: this habit is common to it and to the water-rail. It dives, swims, and even swims under water, when hard pushed."

"These birds disappear in the depth of winter, but return early in the spring; and even in the month of February they are common in some provinces of France and Italy. Their flesh is delicate, and much esteemed: those, in particular, which are caught in the rice-fields in Piedmont are very fat, and of an exquisite flavour."

3. The crex, crane, or corn-creek, has been supposed by some to be the same with the water-rail, and that it differs only by a change of colour at a certain season of the year: this error is owing to inattention to their characters and nature, both which differ entirely. The bill of this species is short, strong, and thick; formed exactly like that of the water-hen, and makes a general distinction. It never frequents watery places; but is always found among corn, grass, broom, or furze. It quits the kingdom before winter; but the water-rail en-

dures our sharpest seasons. They agree in their aversion to flight; and the legs, which are remarkably long for the size of the bird, hang down whilst they are on the wing; they trust their safety to their swiftness on foot, and seldom are sprung a second time but with great difficulty. The land rail lays from 12 to 20 eggs, of a dull white colour, marked with a few yellow spots; notwithstanding this, they are very numerous in this kingdom. Their note is very singular; and like the quail, it is decoyed into a net by the imitation of its cry, *crék crék crék*, by rubbing hard the blade of a knife on an indented bone. Most of the names given in different languages to this bird are evidently formed to imitate this singular cry. Hence Turner and some other naturalists have supposed it to be the crex of the ancients; but that term appears to have been applied by the ancients to other birds. Philus gives the crex the epithet of *βραδυπόδος*, or *sluggish-winged*, which would indeed suit the land-rail. Aristophanes represents it as migrating from Libya: Aristotle says that it is quarrelsome, which may have been attributed to it from the analogy to the quail; but he adds, that the crex seeks to destroy the nests of the blackbird, which cannot apply to the rail, since it never inhabits the woods. Still less is the crex of Herodotus a rail, for he compares its size to that of the ibis, which is ten times larger. The avocet, too, and the teal, have sometimes the cry *crex, crex*: and the bird which Belon heard repeating that cry on the banks of the Nile is, according to his account, a species of godwit. Thus the sound represented by the word *crex*, belonging to several species, is not sufficiently precise to distinguish the land-rail.

They are in greatest plenty in Anglesea, where they appear about the 20th of April, supposed to pass over from Ireland, where they abound: at their first arrival it is common to shoot seven or eight in a morning. They are found in most of the Hebrides, and the Orkneys. On their arrival they are very lean, weighing only six ounces; but before they leave this island, grow so fat as to weigh above eight. The feathers on the crown of the head and hind-part of the neck are black, edged with bay colour: the coverts of the wings of the same colour, but not spotted; the tail is short, and of a deep bay: the belly white; the legs ash-coloured.

RALPH (James), a late ingenious historical and political writer, was born, we know not when or where, being first known as a schoolmaster in Philadelphia in North America. He came to England about the beginning of the reign of George I. and wrote some things in the dramatic way, which were not received with great applause: but though he did not succeed as a poet, he was a very ingenious prose-writer. He wrote A History of England, commencing with the Stuarts, which is much esteemed; as were his political essays and pamphlets, some of which were looked upon as master-pieces. His last publication, The Case of Authors by Profession, is an excellent and entertaining performance. He died in 1762.

RAM, in zoology. See OVIS.

Battering RAM, in antiquity, a military engine used to.

Rallus
||
Rani.

(A) 'I tried (says M. de Querhoent) to raise some: they thrived wonderfully at first, but after a fortnight's confinement their long legs grew paralytic, and the birds could only crawl on their knees; at last they expired.' Gesner says, that having long fed one, he found it to be peevish and quarrelsome."

Ram
Ramesses.

to batter down the walls of besieged places. See *BATTERING Ram*.

RAM's Head, in a ship, is a great block belonging to the fore and main haulyards. It has three flukes in it, in which the haulyards are put; and in a hole at the end are reeved the ties.

RAMADAN, a solemn season of fasting among the Mahometans. See **MAHOMETANISM**.

RAMAH (anc. geog.), a town of Benjamin, near Gibea, (Judges); called *Rama of Saul* (1 Sam. xxii.), six miles from Jerusalem to the north; memorable for the story of the Levite and his concubine: Taken and fortified by Baasa king of Israel, in order to annoy the kingdom of Judah. This Rama is mentioned Isa. x. Jer. xxxi. and Matth. ii. and is to be distinguished from *Rama of Samuel*, 1 Sam. xix. called also *Ramatho*, 1 Sam. i. 19. and *Ramathaim Zophim*, ibid. i. 1. which lay a great way to the west, towards Joppa, near Lydda, 1 Maccab. ii. the birth-place of Samuel; adjoining to the mountains of Ephraim, and the place of his residence, 1 Sam. xv. &c. (Josephus). Called *Ramula* in the lower age, (Gul. Tyrius.) There is here a convent of the Fathers of the Holy Land, inhabited only by Portuguese, Spaniards, and Italians.

RAMATH-MIZPE, (Joshua xiii.); *Ramoth-Maspha*, (Septuagint, Vulgate); *Ramoth in Gilead*, or *Remmath Galsad*, (Seventy); a town in that tract of Gilead called *Maspha*, or *Mizpe*, one of the cities of refuge.

RAMAZZINI (Bernardin), an Italian physician, born at Carpi near Modena in 1633. He was professor of physic in the university of Modena for 18 years; and in 1700 accepted an invitation from Padua, where he was made rector of the college; and died in 1714. His works were collected and published in London, 1716; of which, his treatise *De Morbis Artificum*, "Of the peculiar maladies of artificers," will always be esteemed useful and curious.

RAMEKINS, a fortress of the United Netherlands, on the south coast of the island of Walchevin, in the province of Zeland. One of the cautionary towns given to Queen Elizabeth for the repayment of the charges she had been at for the defence of this republic in its infancy. Four miles east of Flushing; in N. Lat. 51. 34. E. Long. 4. 24.

RAMESES, (anc. geog.); a town built by the Israelites during their bondage in Egypt, and from which the Exodus took place, and which must have been towards and not far from the Arabian Gulph, seeing in the third station the Israelites arrived on its shore.

RAMESES, king of the Lower Egypt when Jacob went thither with his family, in the 1706th year before the Christian era. Ancient authors mention several other kings of Egypt of the same name; and it is thought that one of those princes erected in the temple of the sun at Thebes, the magnificent obelisk which the emperor Constantine caused to be removed to Alexandria in the year 334; and that prince dying, his son Constantius had the obelisk transported from Alexandria to Rome in 352, where it was erected in the grand Circus. Its height was 132 feet. When the Goths sacked the city of Rome in 409, they overthrew this obelisk, which continued buried in the sand till the time of Sixtus V. in 1587, when it was found broken in three pieces; which being joined together, it was set up in the square of St John de Lateran. On the four sides of

this wonderful obelisk are a number of figures and hieroglyphical characters, which, according to the explanation of Ammianus Marcellinus, contain the praises of Rameses. Ramification, Ramillies.

RAMIFICATION, the production of boughs or branches, or of figures resembling branches.

RAMILLIES, a small village of Brabant, in the Austrian Low Countries, 12 miles north of Namur, and 22 south-east of Brussels. Lat. 50. 51. Long. 4. 48. Famous for the battle fought by the allies commanded by the duke of Marlborough and M. D'Auverquerque, against that of the two crowns, commanded by the Duke of Bavaria and Marshal Villeroy, the 22d of May 1706. See **BRITAIN**, n° 357.

The troops destined to compose the army of the allies being joined at the camp of Borchloon the 20th of May, halted the 21st. On the 22d the army marched from Borchloon in four columns, and posted itself the same day, with the right towards the Mill of Quorem, extending with the left towards Blehen: from this camp was discovered the army of the two crowns, which was encamped with the left at Over-Espen, and the right towards the wood of Chapiaroux, Heylisselm in their front, and Tirlemont in their rear. It was resolved the same day to march the next morning towards the plain of Meerdorp or Mierdau, to view the posture of the enemies, and determine what would be the most proper means of attacking them according to the movement they should make. To this end, an advanced guard of 600 horse and all the quarter-masters of the army were sent forward on the 23d at break of day.

The same morning about four, the army marched in eight columns towards the aforesaid plain. The advanced guard and the quarter-masters arrived about eight at the height of Meerdorp or Mierdau; from whence the army of the enemy was seen in motion: a little after it was perceived that the enemy was marching through the plain of Mount St Andrew in four columns, of which information was given to the duke of Marlborough and M. D'Auverquerque, who immediately repaired to the said height; and by the time these generals were arrived there, the head of the enemy's army already appeared at the tomb of Ottomont upon the causeway, near the Mehaigne: whereupon the Duke of Marlborough and M. D'Auverquerque made the army advance with all expedition.

The enemy, as fast as they advanced, ranged in order of battle, with their right towards the tomb of Ottomont upon the Mehaigne, extending with their left to Autr'Eglise; having Tranquiers in front of their right, into which they had thrown several battalions of infantry and 14 squadrons of dragoons, who had dismounted their horses to support them. They had placed many of their infantry and a considerable part of their artillery in the village of Ramillies, which fronted the right of their main body, as well as into the village of Offuz, which fronted the left of their infantry, and into the village of Autr'Eglise, quite on their left. The front between the village of Ramillies and Autr'Eglise was covered by a small stream of water, which rendered the meadows in some places marshes, and also by several roads covered with hedges; which difficulties prevented our cavalry of the right wing from coming to action. As fast as the army of the allies arrived it was ranged in order of battle; with the left towards

Bonnet,

Ramillies Bonnef, and the right towards Folz, and every thing was disposed in order to attack. To this end, four battalions were detached to attack the village of Franquénies, and twelve battalions to attack the village of Ramillies, which were to be supported by the whole infantry.

Our artillery began to cannonade the enemy at one; at about two, the attack began with the post of Franquénies, where our infantry had the good fortune to drive the enemy from the hedges, where they were advantageously posted, and at the same time all the cavalry of our left wing advanced to attack that of the enemy's right; soon after all was in action. Whilst the cavalry were engaged, the village of Ramillies was likewise attacked, and forced after a vigorous resistance.

The battle lasted about two hours, and was pretty obstinate; but so soon as our cavalry had gained ground enough to attack the enemy in flank, they began to give way; at the same time all their infantry were put in disorder, so that the whole retreated in great confusion. The cavalry of their left wing formed a little upon the high ground, between Offuz and Mount St Andrew, to favour their retreat: but after the infantry and cavalry of our right wing had filed off between the bottom of the village of Ramillies and Offuz, the whole army marched in several columns to attack the enemy anew; but they gave way before we could come up with them, and retired in great confusion, some towards the défilé of the Abbey De La Ramée and towards Dongelberge, others towards Judogne, and others again towards Hougarde. They were pursued all night so closely that they were obliged to abandon all their artillery and baggage, part of which was found at Judogne and at Hougarde, with their chests of ammunition.

The enemy lost above 30,000 men, 60 cannon, 8 mortars, standards, colours, baggage, &c.; we about 3000. The rest of the campaign was spent in the sieges of Ostend, Menin, and Aeth. In fourteen days the Duke defeated and dispersed the best appointed army the French ever had, and recovered all Spanish Brabant, the marquisate of the holy Roman empire. The army of the enemy consisted of 76 battalions and 142 squadrons, including the king's household troops (*La Maison du Roi*); and the army of the allies was 74 battalions and 123 squadrons. Considering the importance of the victory, the loss of the allies was very small, not above 1100 being killed, and 2600 wounded.

RAMLA, the modern name of Arimathea. See **ARIMATHEA**.

RAMMER, an instrument used for driving down stones or piles into the ground; or for beating the earth, in order to render it more solid for a foundation.

RAMMER of a Gun, the *Gun-slick*; a rod used in charging of a gun, to drive home the powder, as also the shot, and the wad which keeps the shot from rolling out.

RAMPANT, in heraldry, a term applied to a lion, leopard, or other beast that stands on its hind legs, and rears up his fore-feet in the posture of climbing, showing only half his face, as one eye, &c. It is different from salient, in which the beast seems springing forward as if making a sally.

RAMPART, in fortification, is an elevation of earth round a place capable of resisting the cannon of an enemy; and formed into bastions, curtains, &c.

RAMPHASTOS, the *Toucan*, in ornithology. **Ramphast**
tos,
Ramsay.

RAMSAY (Allan), the Scots pastoral poet, was a barber in Edinburgh in the early part of the present century. His taste in poetry, however, has justly raised him to a degree of fame that may in some measure be considered as a recompense for the frowns of fortune. His songs are in universal esteem; as is also the only dramatic performance attributed to him, viz. *Patie and Roger*, or *The Gentle Shepherd*, a Scots pastoral. He died in 1743; and was rather to the ingenious Mr Ramsay, a celebrated painter of the present age, and who has likewise distinguished himself by some well-written tracts on various branches of polite literature, particularly the *Investigator*.

RAMSAY (Andrew Michael), generally known by the name of the *Chevalier Ramsay*, was a polite Scots writer, born of a good family at Ayr in 1686. His good parts and learning recommended him to be tutor to the son of the earl of Wemyss; after which, conceiving a disgust at the religion in which he had been educated, he in the same ill humour reviewed other Christian churches; and, finding none to his liking, rested for a while in Deism. While he was in this uncertain state of mind, he went to Leyden; where, falling into the company of one Poiret a mystic divine, he received the infection of mysticism: which prompted him to consult M. Fenelon, the celebrated archbishop of Cambray, who had imbibed principles of the same nature; and who gained him over to the Catholic religion in 1709. The subsequent course of his life received its direction from his friendship and connections with this prelate; and being appointed governor to the duke de Chateau Thierry, and the prince de Turenne, he was made a knight of the order of St Lazarus. He was sent for to Rome by the chevalier de St George, to undertake the education of his children; but he found so many intrigues and dissensions on his arrival there in 1724, that he obtained the Chevalier's leave to return to Paris. He died in 1743, in the office of intendant to the duke of Bouillon, prince de Turenne. The most capital work of his writing is the *Travels of Cyrus*, which has been several times printed in English.

RAMSAY (the Reverend James), so justly celebrated for his philanthropy, was, on the 25th of July 1733, born at Fraserburgh, a small town in the county of Aberdeen, North Britain. His descent was honourable, being, through his father, from the Ramsays of Melrose in Banffshire, and through his mother, from the Ogilvies of Purie in Angus. His parents were of characters the most respectable, but in circumstances by no means affluent. From his earliest years he discovered a serious disposition, and a strong thirst for knowledge; and after passing through the course of a Scotch grammar school education, he was inclined to pursue the studies requisite to fit him for the profession of a clergyman; an inclination with which the wishes of his mother, a woman of eminent piety, powerfully concurred. Several circumstances, however, conspired to divert him for a time from his favourite pursuit.

He was educated in the episcopal persuasion; and having been unhappy enough to lose his father while yet very young, he found, upon his advancing towards the state of manhood, that the joint fortunes of himself and

Ramsay. his mother could not bear the expence of a regular education in either of the universities of Oxford or Cambridge, which he doubtless thought absolutely necessary to one who aspired to respectability in the church of England. Yielding therefore to necessity, he resolved to study surgery and pharmacy; and was with this view bound apprentice to Dr Findlay, a physician (A) in Frasersburgh. But though obliged to relinquish for a time his favourite studies, he did not think ignorance excusable in a surgeon more than in a clergyman, or conceive that he could ever become eminent in the profession in which circumstances had placed him, merely by skill in setting a bone or compounding a medicine. He determined therefore, with the full approbation of his master, who very soon discovered his talents for literature, to make himself acquainted with at least the outlines of the liberal arts and sciences; and with this view he repaired in 1750 to the King's College and university of Aberdeen, where he obtained one of the *bursaries* or *exhibitions* which are there annually bestowed upon such candidates for them as display the most accurate knowledge of the Latin language. The small sum of five pounds, however (which none of these bursaries exceed), was still inadequate to the expence of residence in college; but our young student was soon to obtain a more valuable exhibition, and to obtain it likewise by his own merit.

During the long vacation he returned to his master Dr Findlay, and was by him intrusted with a very desperate case in surgery, of which his management may be said to have laid the foundation of his future fortunes. A female servant of one of the judges of the Court of Session, who, when the court was not sitting, resided in the neighbourhood of Frasersburgh, had been so dreadfully gored by a bull, that hardly any hopes were entertained of her recovery; but Mr Ramsay, to whose care she was entirely left, treated the wound with such skillful attention, that, contrary to general expectation, his patient recovered. This attracted the judge's notice, who having informed himself of the young man's circumstances and character, recommended him so effectually to Sir Alexander Ramsay of Balmain, that he presented him with a bursary of 15 pounds a-year, which commenced at the next *session* or *term*, in the same college.

He now prosecuted his studies with comfort; and though he was detained in college a year longer than is usual, being obliged, upon his acceptance of a second bursary, to begin his course anew, he always considered this as a fortunate circumstance, because it gave him the celebrated Dr Reid three years for his preceptor. To that great and amiable philosopher he so recommended himself by his talents, his industry, and his virtues, that he was honoured with his friendship to the day of his death. Nor was it only to his masters that his conduct recommended him; Sir Alexander Ramsay, whom he visited during some of the vacations, was so well pleased with his conversation, that he promised him

another bursary, in his gift, of 25l. a-year, to commence immediately on the expiration of that which he enjoyed. This promise he performed in the beginning of the year 1755; and at the solicitation of Dr Findlay even paid the money per advance to enable the exhibitor to travel for the purpose of improving himself in his profession.

Thus provided, Mr Ramsay went to London, and studied surgery and pharmacy under the auspices of Dr Macaulay; in whose family he lived for two years, carested and esteemed both by him and by his lady. Afterwards, having passed the usual examination at Surgeon's-hall, he served in his medical capacity for several years in the royal navy; but how long he was continued in the station of a mate, or when and by whom he was first appointed surgeon, we have not been able to learn. We can say, however, upon the best authority, that by his humane and diligent discharge of his duty in either station, he endeared himself to the seamen, and acquired the esteem of his officers.

Of his humanity there is indeed one memorable instance, which must not be omitted. Whilst he acted as surgeon of the *Arundel*, then commanded by Captain (now Vice-admiral Sir Charles) Middleton, a slave-ship on her passage from Africa to the West Indies fell in with the fleet to which the *Arundel* belonged. An epidemical distemper, too common in such vessels, had swept away not only a great number of the unfortunate negroes, but also many of the ship's crew, and among others the surgeon. In this distressed situation the commander of the Guinea ship applied to the English Commodore for medical assistance; but not a surgeon or surgeon's mate in the whole fleet, except Mr Ramsay, would expose himself to the contagion of so dangerous a distemper. Prompted, however, by his own innate benevolence, and fully authorized by his no less benevolent commander, the surgeon of the *Arundel*, regardless of personal danger, and trusting in that God to whom mercy is more acceptable than sacrifice, went on board the infected ship, visited all the patients, and remained long enough to leave behind him written directions for their future treatment. If a cup of cold water given in charity be entitled to a reward, how much more such an action as this? But the rewards of Christianity are not immediate. Mr Ramsay indeed escaped the contagion; but on his return to his own ship, just as he had got on the deck, he fell and broke his thigh-bone; by which he was confined to his apartment for ten months, and rendered in a small degree lame through the remainder of his life.

The fearless humanity which he displayed on this occasion, gained him the friendship and esteem of Sir Charles Middleton, which no future action of his life had the smallest tendency to impair; but the fracture of his thigh-bone and his subsequent lameness determined him to quit the navy, and once more turn his thoughts towards the church. Accordingly, while the *Arundel* lay at St Christopher's, he opened his views to some

(A) In the remote towns of Scotland the same man generally acts in the triple capacity of physician, surgeon, and apothecary; and we could mention doctors of physic of the first eminence, who practise thus within forty miles of Edinburgh.

Ramfay.

some of the principal inhabitants of that island, by whom he was so strongly recommended to the bishop of London, that on his coming home with Sir Charles Middleton, who warmly joined in the recommendation, he was admitted into orders; after which he immediately returned to St Christopher's, where he was presented by the governor to two rectories, valued at 700l. a year.

As soon as he took possession of his livings, in 1763, he married Miss Rebecca Akers, the daughter of a planter of the best family-connections in the island, and began to regulate his household on the pious plan inculcated in his *Essay on the Treatment and Conversion of the African Slaves in the British Sugar Colonies*. He summoned all his own slaves daily to the prayers of the family, when he took an opportunity of pointing out to them their duty in the plainest terms, reproving those that had done amiss, and commending such as had shown any thing like virtue; but he confessed that his occasions for reproof were more frequent than for commendation. As became his office and character, he inculcated upon others what he practised himself, and knew to be equally the duty of all. "On his first settlement as a minister in the West Indies, he made some public attempts to instruct slaves. He began to draw up some easy, plain discourses for their instruction. He invited them to attend on Sundays, at particular hours. He appointed hours at home to instruct such sensible slaves as would of themselves attend. He repeatedly exhorted their masters to encourage such in their attendance. He recommended the French custom, of beginning and ending work by prayer. But inconceivable is the listlessness with which he was heard, and bitter was the censure heaped on him in return. It was quickly suggested, and generally believed, that he wanted to interrupt the work of slaves, to give them time, forsooth, to say their prayers; that he aimed at the making of them Christians, to render them incapable of being good slaves. In one word, he stood, in opinion, a rebel convict against the interest and majesty of plantership. And as the Jews say, that in every punishment, with which they have been proved, since the bondage of Egypt, there has been an ounce of the golden calf of Horeb; so might he say, that in every instance of prejudice (and they were not a few) with which, till within a year or two of his departure from the country, he was exercised, there was an ounce of his fruitless attempts to improve the minds of slaves. In the bidding prayer, he had inserted a petition for the conversion of those persons. But it was deemed so disagreeable a memento, that several white people, on account of it, left off attending divine service. He was obliged to omit the prayer entirely, to try and bring them back. In short, neither were the slaves, at that time, desirous of being taught, nor were their masters inclined to encourage them."

That he was hurt by this neglect cannot be questioned, for he had a mind benevolent, warm, and irritable; but he still retained many friends amongst the most worthy members of the community: and as he was conscious of having done nothing more than his duty, he consoled himself with reflecting, that those are "blessed whom men revile, and persecute, and speak all manner of evil against falsely, for the sake of the gospel."

Although his serious studies were now theological, he considered himself as answerable to God, his country,

VOL. XV. Part II.

and his own family, for a proper use of every branch of knowledge which he possessed. He therefore took the charge of several plantations around him in the capacity of a medical practitioner; and attended them with unremitting diligence, and with great success. Thus he lived till the year 1777, when relinquishing the practice of physic entirely, he paid a visit to the place of his nativity, which he had not seen since 1755. His mother, whose latter days he had made comfortable by a handsome annuity, had been dead for some years; but he rewarded all who had been attentive to her, or in early life serviceable to himself; and he continued the pension to a sister who had a numerous family, for which her husband was unable to provide.

After remaining three weeks in Scotland, and near a year in England, during which time he was admitted into the confidence of Lord George Germaine, secretary of state for the American department, Mr Ramfay was appointed chaplain to Admiral Barrington, then going out to take a command in the West Indies. Under this gallant officer, and afterwards under Lord Rodney, he was present at several engagements, where he displayed a fortitude and zeal for the honour of his country which would not have disgraced the oldest admiral. To the navy, indeed, he seems to have been strongly attached; and he wrote, at an early period of his life, an *Essay on the Duty and Qualifications of a Sea-officer*, with such a knowledge of the service as would have done honour to the pen of the most experienced commander. Of the first edition of this essay the profits were by its benevolent author appropriated to the Magdalen and British lying-in hospitals, as those of the second and third (which last was published about the period of which we now write) were to the maritime school, or, in the event of its failure, to the marine society.

Although caressed by both the admirals under whom he served, and having such influence with the latter as to be able to render essential services to the Jews and other persons whom he thought harshly treated at the capture of St Eustatius, Mr Ramfay once more quitted the sea-service, and retired to his pastoral charge in the Island of St Christopher's. There, however, though the former animosities against him had entirely subsided, and though his friendship was now solicited by every person of consequence in the island, he remained but a little while. Sick of the life of a planter and of the prospect of slavery around him, he resigned his livings, bade adieu to the island, and returned to England with his wife and family in the end of the year 1781. Immediately on his arrival, he was, through the interest of his steady friend Sir Charles Middleton, presented to the livings of Teilton and Nettlestead in the county of Kent.

Here he was soon determined, by the advice of those whom he most respected, to publish an *Essay*, which had been written many years before, on the *Treatment and Conversion of African Slaves in the British Sugar Colonies*. The controversy in which this publication involved him, and the acrimony with which it was carried on, are so fresh in the memory of all our readers, that no man who thinks of the narrow limits within which our biographical articles must be confined, will blame us for not entering into a detail of the particulars.— Torrents of obloquy were poured upon the benevolent author by writers who were unfair enough to conceal their

Ramfay.

Ramsden's
Machine.

their names; and it must be confessed, that his replies abounded with sarcasms, which the most rational friends to the cause which he supported would not have been sorry to see blotted from his pages. The provocation, however, which he received was great; and Mr Ramsden, though an amiable, virtuous, and pious man, had a warmth of temper, which, though not deserving of praise, will be censured by none who reflect on the frailties of our common nature. That the particular calumnies propagated against him on this occasion were wholly groundless, it is impossible to doubt, if we admit him to have been possessed of common understanding. When some years ago a story was circulated, of Swift's having, when prebendary of Kilroot, been convicted before a magistrate of an attempt to commit a rape on the body of one of his parishioners, it was thought a sufficient confutation of the calumny to put the retailer of it in mind, that the dean of St Patrick's, though detested by the most powerful faction in the kingdom, lampooned without dread, and with great severity, the dean of Ferns for the very crime of which, had this anecdote been true, he must have been conscious that all Ireland knew himself to be guilty! Such conduct cannot be reconciled to common sense. Had Swift been a ravisher, though he might have been penitent, and reasoned in general terms against giving way to such licentious passions, he would never have satyrised a *particular person* for the crime of which he himself stood convicted. In like manner, had Mr Ramsden been a tyrant to his own slaves, though he might have argued against slavery in the abstract, on the broad basis of virtue and religion, he never could have arraigned for similar cruelty a number of individuals in the very island which witnessed his own enormities.

But the melancholy part of the narrative is behind. The agitation given to his mind by these calumnies, and the fatigues he underwent in his endeavours to rescue from misery the most helpless portion of the human race, contributed to shorten a life in no common degree useful. He had been for some time afflicted with a pain in his stomach, for which he was prevailed upon, tho' with great reluctance, to try the effects of air and exercise, by attempting a journey of 100 miles. But in London, being seized with a violent vomiting of blood, he was unable either to proceed or to be removed home; and in the house of Sir Charles Middleton he ended his days, on the 20th of July 1789, amidst the groans of his family, and the tears of many friends.—Thus died a man, of whom it is not too much to say, that "the blessing of many that were ready to perish came upon him;" for whatever be the fate of the slave-trade (see SLAVERY), it is certain that his writings have contributed much to meliorate the treatment of slaves. He left behind him a widow and three daughters: and his works, besides those to which we have alluded, consist of a volume of *Sea-sermons*, preached on board his majesty's ship the Prince of Wales, which show him to have been a master of true pulpit-eloquence; and a *Treatise on Signals*, which was certainly written, and we think printed, though we know not whether it was ever published.

RAMSDEN'S MACHINE for Dividing MATHEMATICAL INSTRUMENTS, is a late invention, by which these divisions can be performed with exceeding great accuracy, such as would formerly have been deemed in-

credible. On discovering the method of constructing this machine, its inventor, Mr Ramsden of Piccadilly, received 615 l. from the commissioners of longitude; engaging himself to instruct a certain number of persons, not exceeding ten, in the method of making and using this machine from the 28th October 1775 to 28th October 1777: also binding himself to divide all octants and sextants by the same engine, at the rate of three shillings for each octant, and six shillings for each brass sextant, with Nonius's divisions to half minutes, for as long time as the commissioners should think proper to let the engine remain in his possession. Of this sum of 615 l. paid to Mr Ramsden, 300 l. was given him as a reward for the improvement made by him in discovering the engine, and the remaining 315 l. for his giving up the property of it to the commissioners. The following description of the engine, is that given upon oath by Mr Ramsden himself.

"This engine consists of a large wheel of bell-metal, supported on a mahogany stand, having three legs, which are strongly connected together by braces, so as to make it perfectly steady. On each leg of the stand is placed a conical friction-pulley, whereon the dividing-wheel rests: to prevent the wheel from sliding off the friction-pulleys, the bell-metal centre under it turns in a socket on the top of the stand.

"The circumference of the wheel is ratched or cut (by a method which will be described hereafter) into 2160 teeth, in which an endless screw acts. Six revolutions of the screw will move the wheel a space equal to one degree.

"Now a circle of brass being fixed on the screw arbor, having its circumference divided into 60 parts, each division will consequently answer to a motion of the wheel of 10 seconds, six of them will be equal to a minute, &c.

"Several different arbors of tempered steel are truly ground into the socket in the centre of the wheel. The upper parts of the arbors that stand above the plane are turned of various sizes, to suit the centres of different pieces of work to be divided.

"When any instrument is to be divided, the centre of it is very exactly fitted on one of these arbors; and the instrument is fixed down to the plane of the dividing wheel, by means of screws, which fit into holes made in the radii of the wheel for that purpose.

"The instrument being thus fitted on the plane of the wheel, the frame which carries the dividing-point is connected at one end by finger-screws with the frame which carries the endless screw; while the other end embraces that part of the steel arbor, which stands above the instrument to be divided, by an angular notch in a piece of hardened steel; by this means both ends of the frame are kept perfectly steady and free from any shake.

"The frame carrying the dividing-point or tracer, is made to slide on the frame which carries the endless screw to any distance from the centre of the wheel as the radius of the instrument to be divided may require, and may be there fastened by tightening two clamps; and the dividing-point or tracer being connected with the clamps by the double-jointed frame, admits a free and easy motion towards or from the centre for cutting the divisions, without any lateral shake.

"From what has been said, it appears, that an in-

Ramsden's
Machine.

Randlen's
Machine.

Instrument thus fitted on the dividing-wheel may be moved to any angle by the screw and divided circle on its arbor, and that this angle may be marked on the limb of the instrument with the greatest exactness by the dividing-point or tracer, which can only move in a direct line tending to the centre, and is altogether freed from those inconveniences that attend cutting by means of a straight edge. This method of drawing lines will also prevent any error that might arise from an expansion or contraction of the metal during the time of dividing.

"The screw-frame is fixed on the top of a conical pillar, which turns freely round its axis, and also moves freely towards or from the centre of the wheel, so that the screw-frame may be entirely guided by the frame which connects it with the centre: by this means any excentricity of the wheel and the arbor would not produce any error in the dividing; and, by a particular contrivance (which will be described hereafter), the screw when pressed against the teeth of the wheel always moves parallel to itself; so that a line joining the centre of the arbor and the tracer continued, will always make equal angles with the screw.

Plate
CCCCXXXIII

"Figure 1. represents a perspective view of the engine.

Plate
CCCCXXXIV

"Fig. 2. is a plan, of which fig. 3. represents a section on the line ΠA .

"The large wheel A is 45 inches in diameter, and has ten radii, each being supported by edge-bars, as represented in fig. 3. These bars and radii are connected by the circular ring B, 24 inches in diameter and 3 deep; and, for greater strength, the whole is cast in one piece in bell-metal.

"As the whole weight of the wheel A rests on its ring B, the edge-bars are deepest where they join it; and from thence their depth diminishes, both towards the centre and the circumference, as represented in fig. 3.

"The surface of the wheel A was worked very even and flat, and its circumference turned true. The ring C, of fine brass, was fitted very exactly on the circumference of the wheel; and was fastened thereon with screws, which, after being screwed as tight as possible, were well rivetted. The face of a large chuck being turned very true and flat in the lathe, the flattened surface A of the wheel was fastened against it with hold-fasts; and the two surfaces and circumference of the ring C, a hole through the centre and the plane part round (b) it, and the lower edge of the ring B, were turned at the same time.

Fig. 3.

"D is a piece of hard bell-metal, having the hole, which receives the steel-arbor (d), made very straight and true. This bell-metal was turned very true on an arbor; and the face, which rests on the wheel at (b), was turned very flat, so that the steel arbor (d) might stand perpendicular to the plane of the wheel: this bell-metal was fastened to the wheel by six steel screws (l).

"A brass socket Z is fastened on the centre of the mahogany stand, and receives the lower part of the bell-metal piece D, being made to touch the bell-metal in a narrow part near the mouth, to prevent any obliquity of the wheel from bending the arbor: good fitting is by no means necessary here; since any shake

in this socket will produce no bad effect, as will appear hereafter when we describe the cutting frame.

"The wheel was then put on its stand, the lower edge of the ring B resting on the circumference of three conical friction-pulleys W, to facilitate its motion round its centre. The axis of one of these pulleys is in a line joining the centre of the wheel and the middle of the endless screw, and the other two placed so as to be at equal distances from each other.

"F is a block of wood strongly fastened to one of the legs of the stand; the piece (g) is screwed to the upper side of the block, and has half holes, in which the transverse axis (h) turns: the half holes are kept together by the screws (i).

"The lower extremity of the conical pillar P terminates in a cylindrical steel-pin (k), which passes through and turns in the transverse axis (h), and is confined by a check and screw.

"To the upper end of the conical pillar is fastened the frame G, in which the endless screw turns: the pivots of the screw are formed in the manner of two frustums of cones joined by a cylinder, as represented at X. These pivots are confined between half poles, which press only on the conical parts, and do not touch the cylindric parts: the half holes are kept together by screws (a), which may be tightened at any time, to prevent the screw from shaking in the frame.

"On the screw-arbor is a small wheel of brass K, having its outside edge divided into 60 parts, and numbered at every 6th division with 1, 2, &c. to 10. The motion of this wheel is shown by the index (y) on the screw-frame G.

"H represents a part of the stand, having a parallel slit in the direction towards the centre of the wheel, large enough to receive the upper part of the conical brass pillar P, which carries the screw and its frame; and as the resistance, when the wheel is moved by the endless screw, is against that side of the slit H which is towards the left hand, that side of the slit is faced with brass, and the pillar is pressed against it by a steel spring on the opposite side: by this means the pillar is strongly supported laterally, and yet the screw may be easily pressed from or against the circumference of the wheel, and the pillar will turn freely on its axis to take any direction given it by the frame L.

"At each corner of the piece I are screws (n) of tempered steel, having polished conical points: two of them turn in conical holes in the screw-frame near (o), and the points of the other two screws turn in holes in the piece Q; the screws (p) are of steel, which being tightened, prevent the conical pointed screws from unturning when the frame is moved.

"L is a brass frame, which serves to connect the endless screw, its frame, &c. with the centre of the wheel: each arm of this frame is terminated by a steel screw, that may be passed through any of the holes (q) in the piece Q, as the thickness of work to be divided on the wheel may require, and are fastened by the finger-nuts (r).

"At the other end of this frame is a flat piece of tempered steel (b), wherein is an angular notch: when the endless screw is pressed against the teeth on the circumference of the wheel, which may be done by turning the finger-screw S, to press against the spring (t),

Randlen's
Machine.

Fig. 1, 2,
and 3.

Fig. 1.

Fig. 4.

Fig. 1. & 4.

Fig. 4.

Fig. 4.

Fig. 5.

Fig. 1, 2,
4, 5.

Fig. 1.

Fig. 4.

Fig. 1, 2, 6.

Fig. 4.

Fig. 1. & 2.

Fig. 6.

Fig. 1. & 2.

Ramsden's Machine. (d). This end of the frame may be raised or depressed by moving the prismatic slide (u), which may be fixed at any height by the four steel-screws (v).

Fig. 2.

Fig. 1, 2, 6.

Fig. 1. & 6.

Fig. 3.

Fig. 1, 2.

"The bottom of this slide has a notch (k), whose plane is parallel to the endless-screw; and by the point of the arbor (d) resting in this notch, this end of the frame is prevented from tilting. The screw S is prevented from unturning, by tightening the finger-nut (w).

"The teeth on the circumference of the wheel were cut by the following method:

"Having considered what number of teeth on the circumference would be most convenient, which in this engine is 2160, or 360 multiplied by 6, I made two screws of the same dimensions, of tempered steel, in the manner hereafter described, the interval between the threads being such as I knew by calculation would come within the limits of what might be turned off the circumference of the wheel: one of these screws, which was intended for ratching or cutting the teeth, was notched across the threads, so that the screw, when pressed against the edge of the wheel and turned round, cut in the manner of a saw. Then having a segment of a circle a little greater than 60 degrees, of about the same radius with the wheel, and the circumference made true, from a very fine centre, I described an arch near the edge, and set off the chord of 60 degrees on this arch. This segment was put in the place of the wheel, the edge of it was ratched, and the number of revolutions and parts of the screw contained between the interval of the 60 degrees were counted. The radius was corrected in the proportion of 360 revolutions, which ought to have been in 60 degrees, to the number actually found; and the radius, so corrected, was taken in a pair of beam-compasses: while the wheel was on the lath, one foot of the compasses was put in the centre, and with the other a circle was described on the ring; then half the depth of the threads of the screw being taken in dividers, was set from this circle outwards, and another circle was described cutting this point; a hollow was then turned on the edge of the wheel of the same curvature as that of the screw at the bottom of the threads: the bottom of this hollow was turned to the same radius or distance from the centre of the wheel, as the outward of the two circles before-mentioned.

Fig. 3.

"The wheel was now taken off the lath; and the bell-metal piece D was screwed on as before directed, which after this ought not to be removed.

Fig. 1, 2, 3.

"From a very exact centre a circle was described on the ring C, about $\frac{1}{8}$ of an inch within where the bottom of the teeth would come. This circle was divided with the greatest exactness I was capable of, first into five parts, and each of these into three. These parts were then bisected four times: (that is to say) supposing the whole circumference of the wheel to contain 2160 teeth, this being divided into five parts, each would contain 432 teeth; which being divided into three parts, each of them would contain 144; and this space

bisected four times would give 72, 36, 18, and 9: therefore each of the last divisions would contain nine teeth. But, as I was apprehensive some error might arise from quinquesection and trisection, in order to examine the accuracy of the divisions, I described another circle on the ring C, $\frac{1}{8}$ inch within the former, and divided it by continual bisections, as 2160, 1080, 540, 270, 135, 67 $\frac{1}{2}$, and 33 $\frac{1}{2}$; and as the fixed wire (to be described presently) crossed both the circles, I could examine their agreement at every 135 revolutions; (after ratching, could examine it at every 33 $\frac{1}{2}$): but, not finding any sensible difference between the two sets of divisions, I, for ratching, made choice of the former; and, as the coincidence of the fixed wire with an intersection could be more exactly determined than with a dot or division, I therefore made use of intersections in both circles before described.

Ramsden's Machine.

Fig. 7.

"The arms of the frame L were connected by a thin piece of brass of $\frac{1}{4}$ of an inch broad, having a hole in the middle of $\frac{1}{8}$ of an inch in diameter; across this hole a silver wire was fixed exactly in a line to the centre of the wheel; the coincidence of this wire with the intersections was examined by a lens $\frac{7}{8}$ inch focus, fixed in a tube which was attached to one of the arms L (A). Now a handle or winch being fixed on the end of the screw, the division marked 10 on the circle K was set to its index, and, by means of a clamp and adjusting screw for that purpose, the intersection marked 1 on the circle C was set exactly to coincide with the fixed wire; the screw was then carefully pressed against the circumference of the wheel, by turning the finger-screw S; then, removing the clamp, I turned the screw by its handle 9 revolutions, till the intersection marked 240 came nearly to the wire; then, unturning the finger-screw S, I released the screw from the wheel, and turned the wheel back till the intersection marked 2 exactly coincided with the wire, and, by means of the clamp before-mentioned, the division 10 on the circle being set to its index, the screw was pressed against the edge of the wheel by the finger-screw S; the clamps were removed, and the screw turned nine revolutions till the intersection marked 1 nearly coincided with the fixed wire; the screw was released from the wheel by unturning the finger-screw S as before, the wheel was turned back till the intersection 3 coincided with the fixed wire; the division 10 on the circle being set to its index, the screw was pressed against the wheel as before, and the screw was turned 9 revolutions, till the intersection 2 nearly coincided with the fixed wire, and the screw was released; and I proceeded in this manner till the teeth were marked round the whole circumference of the wheel. This was repeated three times round, to make the impression of the screw deeper. I then ratched the wheel round continually in the same direction without ever disengaging the screw; and, in ratching the wheel about 300 times round, the teeth were finished.

"Now it is evident, if the circumference of the wheel was even one tooth or ten minutes greater than the screw would require, this error would in the first instance

(A) The intersections are marked for the sake of illustration, though properly invisible, they lying under the brass plate.

Ramsden's
Machine.

Ramsden's
Machine.

stance be reduced to $\frac{1}{10}$ part of a revolution, or two seconds and a half; and these errors or inequalities of the teeth were equally distributed round the wheel at the distance of nine teeth from each other. Now, as the screw in ratcheting had continually hold of several teeth at the same time, and, these constantly changing, the above-mentioned inequalities soon corrected themselves, and the teeth were reduced to a perfect equality. The piece of brass which carries the wire was now taken away, and the cutting screw was also removed, and a plain one (hereafter described) put in its place: on one end of the screw is a small brass circle, having its edge divided into 60 equal parts, and numbered at every sixth division, as before-mentioned. On the other end of the screw is a ratchet-wheel C, having 60 teeth, covered by the hollowed circle (d), which carries two clicks that catch upon the opposite sides of the ratchet when the screw is to be moved forwards. The cylinder S turns on a strong steel arbor F, which passes through and is firmly screwed to the piece Y: this piece, for greater firmness, is attached to the screw-frame G by the braces (v): a spiral groove or thread is cut on the outside of the cylinder S, which serves both for holding the string, and also giving motion to the lever J on its centre by means of a steel tooth (n), that works between the threads of the spiral. To the lever is attached a strong steel pin (m), on which a brass socket (r) turns: this socket passes through a slit in the piece (p), and may be tightened in any part of the slit by the finger-nut (f): this piece serves to regulate the number of revolutions of the screw for each tread of the treadle R.

Fig. 5.

Fig. 4.

Fig. 1.

Fig. 1.

Fig. 4.

Fig. 1.

Fig. 1.

"T is a brass box containing a spiral spring; a strong gut is fastened and turned three or four times round the circumference of this box; the gut then passes several times round the cylinder S, and from thence down to the treadle R. Now, when the treadle is pressed down, the string pulls the cylinder S round its axis, and the clicks catching hold of the teeth on the ratchet carry the screw round with it, till, by the tooth (n) working in the spiral groove, the lever J is brought near the wheel (d), and the cylinder stopped by the screw-head (x) striking on the top of the lever J; at the same time the spring is wound up by the other end of the gut passing round the box T. Now, when the foot is taken off the treadle, the spring unbending itself pulls back the cylinder, the clicks leaving the ratchet and screw at rest till the piece (t) strikes on the end of the piece (p): the number of revolutions of the screw at each tread is limited by the number of revolutions the cylinder is allowed to turn back before the stop strikes on the piece (p).

Fig. 1. & 4.

"When the endless screw was moved round its axis with a considerable velocity, it would continue that motion a little after the cylinder S was stopped: to prevent this, the angular lever α was made; that when the lever J comes near to stop the screw (x), it, by a small chamfer, presses down the piece α of the angular lever; this brings the other end μ of the same lever forwards, and stops the endless screw by the steel pin μ striking upon the top of it: the foot of the lever is raised again by a small spring pressing on the brace (v).

"D, two clamps, connected by the piece α , slide one on each arm of the frame L, and may be fixed at

pleasure by the four finger-screws, which press against steel springs to avoid spoiling the arms: the piece (q) is made to turn without shake between two conical pointed screws (f), which are prevented from unturning by tightening the finger-nuts N.

"The piece M is made to turn on the piece (q), by Fig. 6. the conical pointed screws (f) resting in the hollow centers (e).

"As there is frequent occasion to cut divisions on inclined planes, for that purpose the piece γ , in which the tracer is fixed, has a conical axis at each end, which turn in half holes: when the tracer is set to any inclination, it may be fixed there by tightening the steel screws δ .

Description of the Engine by which the endless screw of the Dividing Engine was cut.

"Fig. 9. represents this engine of its full dimensions seen from one side.

"Fig. 8. the upper side of the same as seen from above.

"A represents a triangular bar of steel, to which the triangular holes in the pieces B and C are accurately fitted, and may be fixed on any part of the bar by the screws D.

"E is a piece of steel whereon the screw is intended to be cut; which, after being hardened and tempered, has its pivots turned in the form of two frustums of cones, as represented in the drawings of the dividing engine (fig. 5.). These pivots were exactly fitted to the half holes F and T, which were kept together by the screws Z.

"H represents a screw of untempered steel, having a pivot I, which turns in the hole K. At the other end of the screw is a hollow centre, which receives the hardened conical point of the steel pin M. When this point is sufficiently pressed against the screw, to prevent its shaking, the steel pin may be fixed by tightening the screws Y.

"N is a cylindric nut, moveable on the screw H; which, to prevent any shake, may be tightened by the screws O. This nut is connected with the saddle-piece P by means of the intermediate universal joint W, through which the arbor of the screw H passes. A front view of this piece, with a section across the screw arbor, is represented at X. This joint is connected with the nut by means of two steel slips S, which turn on pins between the cheeks T on the nut N. The other ends of these slips S turn in like manner on pins (a). One axis of this joint turns in a hole in the cock (b), which is fixed to the saddle-piece; and the other turns in a hole (d), made for that purpose in the same piece on which the cock (b) is fixed. By this means, when the screw is turned round, the saddle-piece will slide uniformly along the triangular bar A.

"K is a small triangular bar of well-tempered steel, which slides in a groove of the same form on the saddle-piece P. The point of this bar or cutter is formed to the shape of the thread intended to be cut on the endless screw. When the cutter is set to take proper hold of the intended screw, it may be fixed by tightening the screw (e), which presses the two pieces of brass G upon it.

"Having measured the circumference of the dividing-wheel, I found it would require a screw about one thread

Ramsley. thread in a hundred coarser than the guide-screw H. The wheels on the guide-screw arbor H, and that on the steel E, on which the screw was to be cut, were proportioned to each other to produce that effect, by giving the wheel L 198 teeth, and the wheel Q 200. These wheels communicated with each other by means of the intermediate wheel R, which also served to give the threads on the two screws the same direction.

"The saddle-piece P is confined on the bar A by means of the pieces (g), and may be made to slide with a proper degree of tightness by the screws (n)."

For Ramsden's equatorial or portable observatory, see OPTICS, n° 102. and ASTRONOMY, n° 504. See also a long account of an equatorial instrument made by Mr Ramsden by the direction of Sir George Shuckburgh in the Philosophical Transactions for 1793, art. x. p. 67. In this instrument the circle of declinations is four feet in diameter, and may be observed nearly to a second. The glass is placed between six pillars, which form the axis of the machine, and turn round by two pivots placed on two blocks of stone. See also BAROMETER.

RAMSEY, a town of Huntingdonshire, 68 miles north of London, and 12 north-east of Huntingdon. It is situated as it were in an island, being everywhere encompassed with fens, except on the west, where it is separated from the *terra firma* by a causeway for two miles. The neighbouring meers of Ramsley and Whitlesey, which are formed by the river Nyne, abound with fowl and fish, especially eel and large pikes. It was once famous for a very rich abbey, part of the gatehouse of which is still standing, and a neglected statue of Ailwin; the epitaph of whose tomb, which is reckoned one of the oldest pieces of English sculpture extant, styles him "kinsman of the famous King Edward, alderman of all England, and the miraculous founder of this abbey." It was dedicated to St Dunstan, and its abbots were mitred, and sat in parliament; and so many kings of England were benefactors to it, that its yearly rents, says Camden, were 7000*l*. The town was then called *Ramsley the Rich*; but by the dissolution of the abbey it soon became poor, and even lost its market for many years, till about 185 years ago it recovered it. It is held on Saturday, and is reckoned one of the most plentiful and cheapest in England. In the year 1721 a great number of Roman coins was found here, supposed to have been hid by the monks on some incursion of the Danes. There is a charity school in the town for poor girls. W. Long. 0. 19. N. Lat. 52. 26.

RAMSEY, an island of south Wales, on the coast of Pembrokeshire, about two miles in length, and a mile and a half broad. Near it are several small ones, known by the name of the *bishop and his clerks*. It is four miles west of St David's, and 17 north-west of Milford haven. It belongs to the bishopric of St David's, and was in the last age, says Camden, famous for the death of one Justinian, a most holy man, who retiring hither from Brittany, in that age rich in saints, and devoting himself entirely to God, lived a long while in solitude, and being at last murdered by his servant was enrolled among the martyrs. W. Long. 5. 20. N. Lat. 51. 55.

RAMSEY, in the Isle of Man, to the north, a most

noted and spacious haven, in which the greatest fleet may ride at anchor with safety enough from all winds but the north-east, and in that case they need not be embayed. This town standing upon a beach of loose sand, or shingle, is in danger, if not timely prevented, of being washed away by the sea.

RAMSGATE, a sea-port town of Kent, in the isle of Thanet, five miles from Margate, where a very fine pier has been lately built for the security of ships that come into the harbour, being seated near the Downs, between the north and south Foreland, 10 miles north-east of Canterbury. The town is situated in the cove of a chalky cliff. It was formerly but an obscure fishing village, but since the year 1688 has been improved and enlarged by a successful trade to Russia and the east country. But what renders it most worthy of notice, and attracts multitudes of strangers, is the new harbour, which is one of the most capacious in England, if not in Europe. It was begun in the year 1750, but delayed by various interruptions. It consists of two piers; that to the east is built wholly of Purbeck stone, and extends itself into the ocean near 800 feet before it forms an angle; its breadth on the top is 26 feet, including a strong parapet wall, which runs along the outside of it. The other to the west is constructed of wood as far as the low-water mark, but the rest is of stone. The angles, of which there are five in each pier, consist of 160 feet each, with octagons at the end of 60 feet diameter, leaving an entrance of 200 feet into the harbour, the depth of which admits of a gradual increase of 18 to 36 feet. E. Long. 1. 30. N. Lat. 51. 22.

RAMTRUT, a deity worshipped by the Ranazins of Hindostan, where he has a celebrated temple at Onor. He is represented as more resembling a monkey than a man.

RAMUS, in general, denotes a branch of any thing, as of a tree, an artery, &c. In the anatomy of plants it means the first or lateral branches, which go off from the petiolum, or middle rib of a leaf. The subdivisions of these are called *furculi*; and the final divisions into the most minute of all, are by some called *capillamenta*; but both kinds are generally denominated *furculus*.

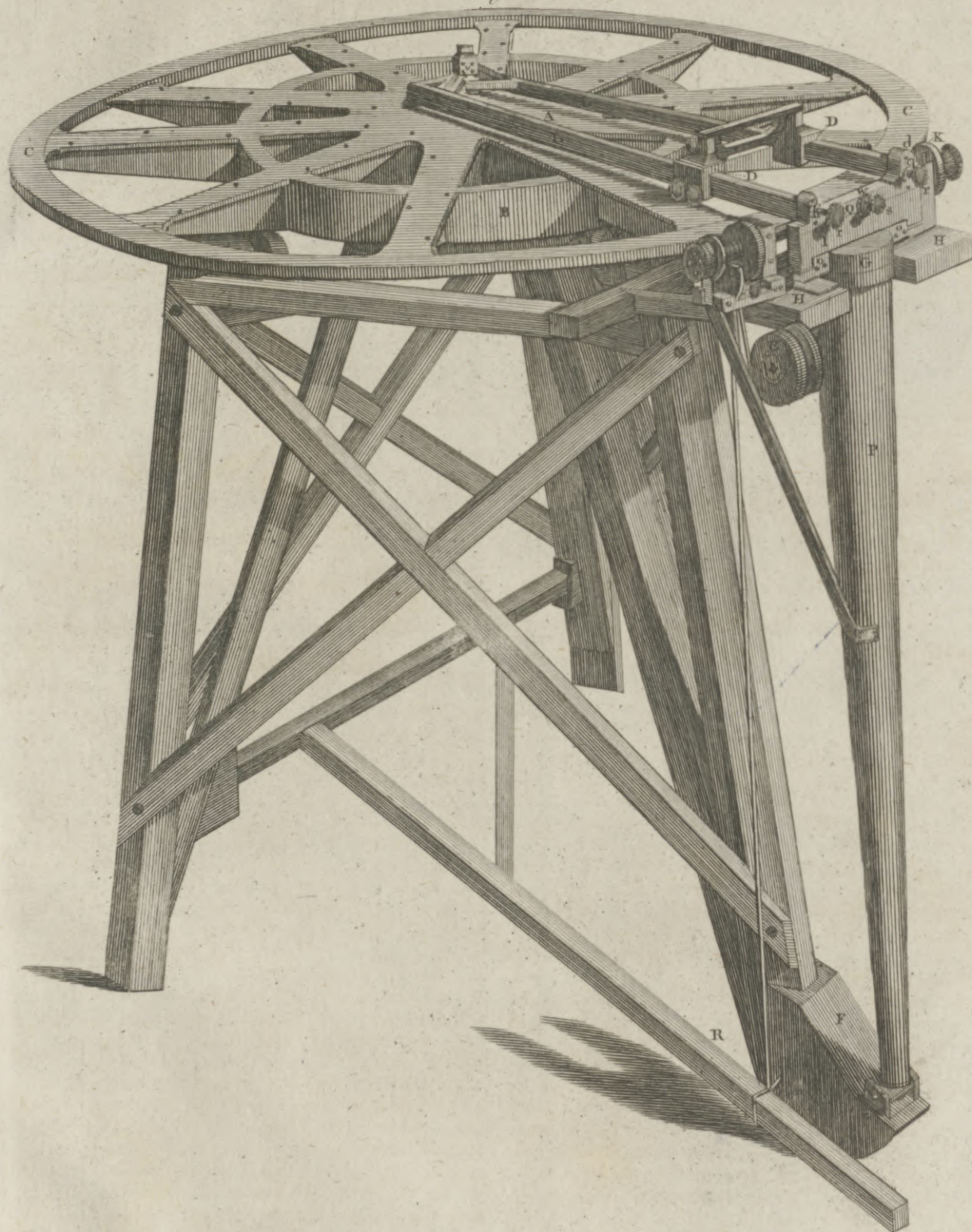
RAMUS (Peter), was one of the most famous professors of the 16th century. He was born in Picardy in 1515. A thirst for learning prompted him to go to Paris when very young, and he was admitted a servant in the college of Navarre. Spending the day in waiting on his masters, and the greatest part of the night in study, he made such surprising progress, that, when he took his master of arts degree, he offered to maintain a quite opposite doctrine to that of Aristotle. This raised him many enemies; and the two first books he published, *Institutiones Dialecticæ*, and *Aristotelicæ Animadversiones*, occasioned great disturbances in the university of Paris: and the opposition against him was not a little heightened by his deserting the Romish religion, and professing that of the Reformed. Being thus forced to retire from Paris, he visited the universities of Germany, and received great honours wherever he came. He returned to France in 1571, and lost his life miserably in the horrid massacre of St Bartholomew's day. He was a great orator, a man of universal learning, and endowed with very fine moral qualities.

Ramsgate

Ramus.

RAMSDENS Machine
for dividing Mathematical Instruments.
Fig. 1.

Plate CCCCXXXIII.



J. Bell, Sculp. del. J. Smith, fecit.

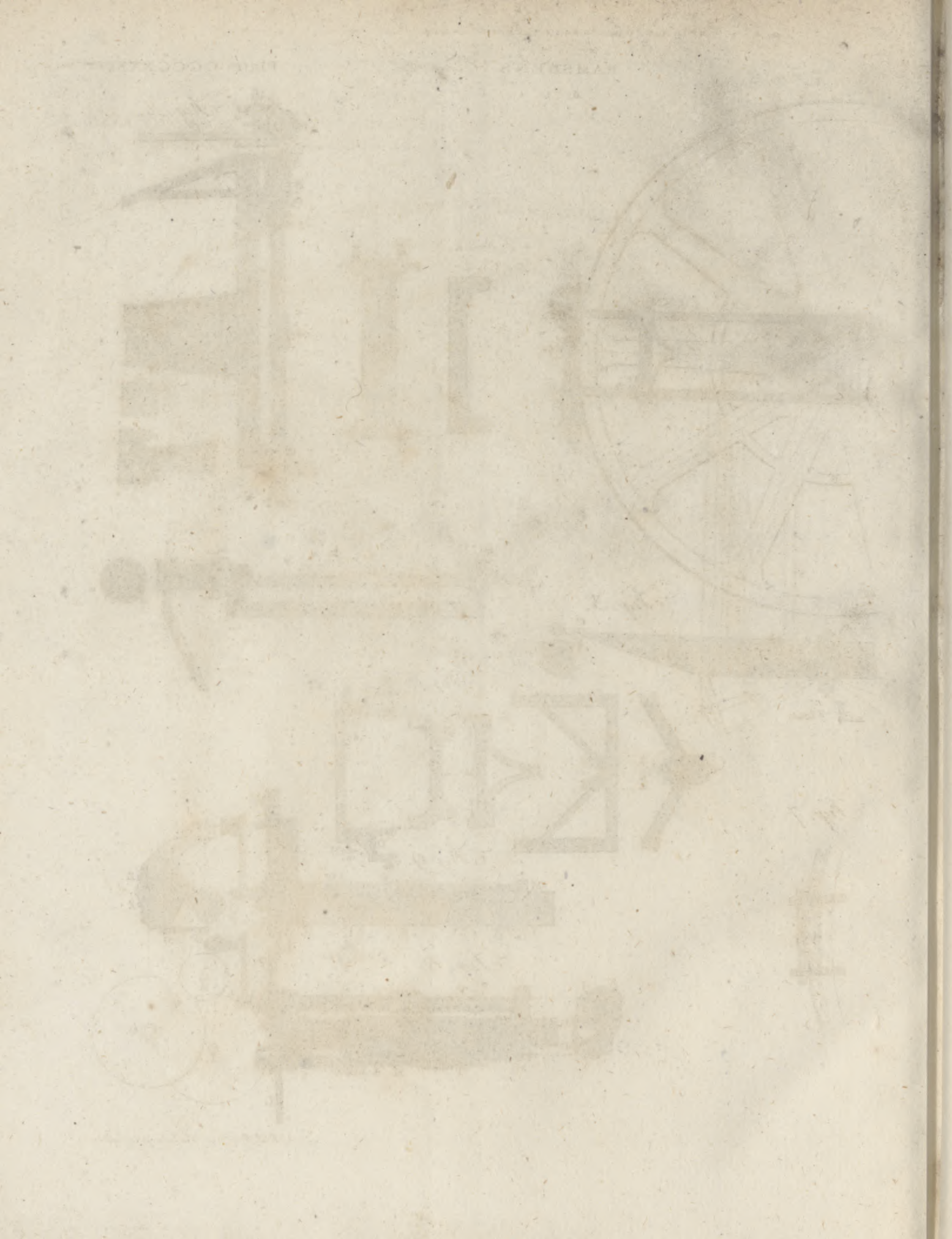


Fig. 2.

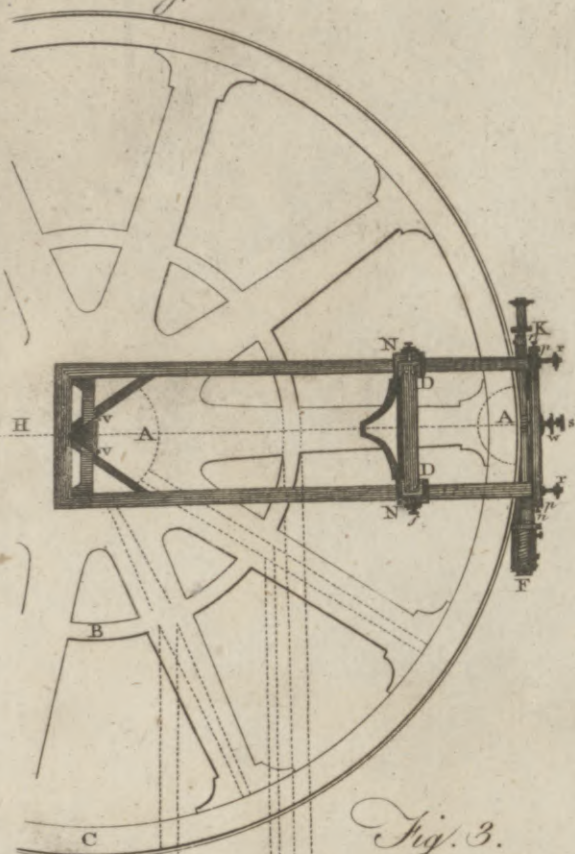


Fig. 3.

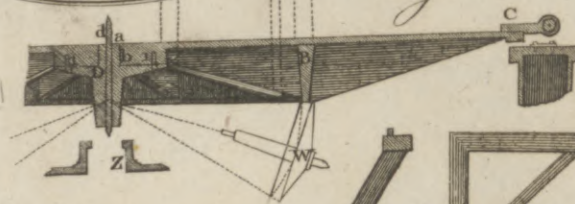


Fig. 7.

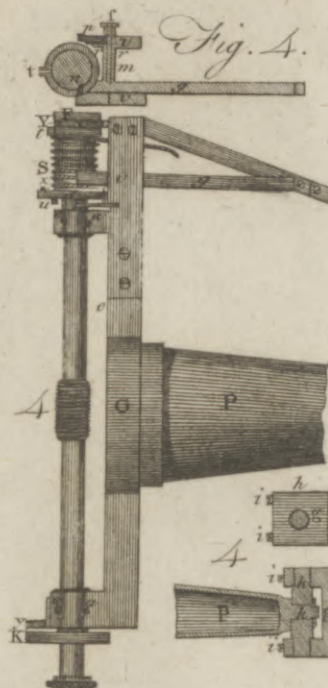
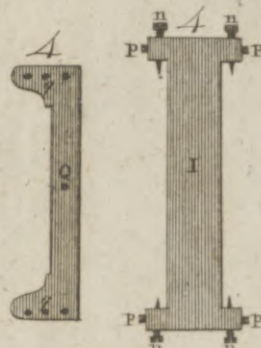


Fig. 5.

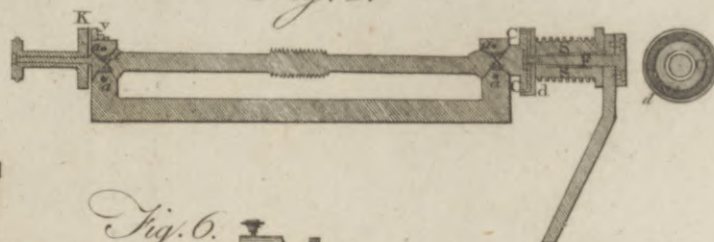


Fig. 6.

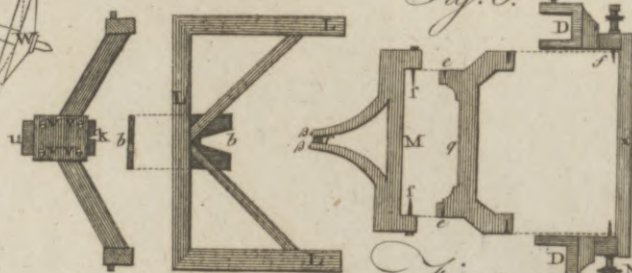


Fig. 9.

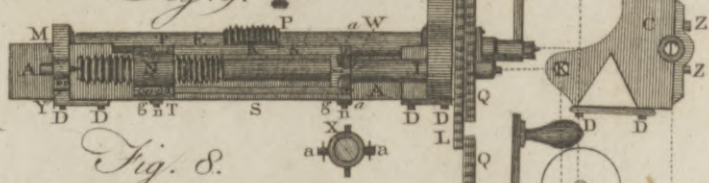
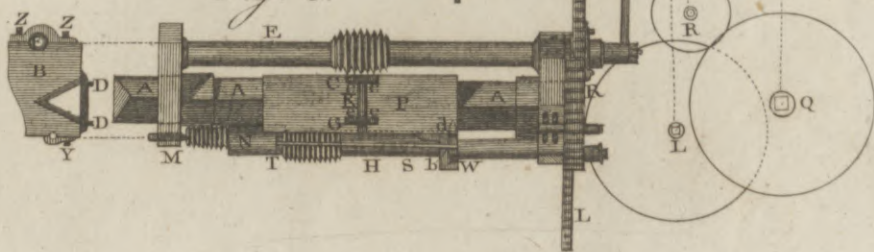
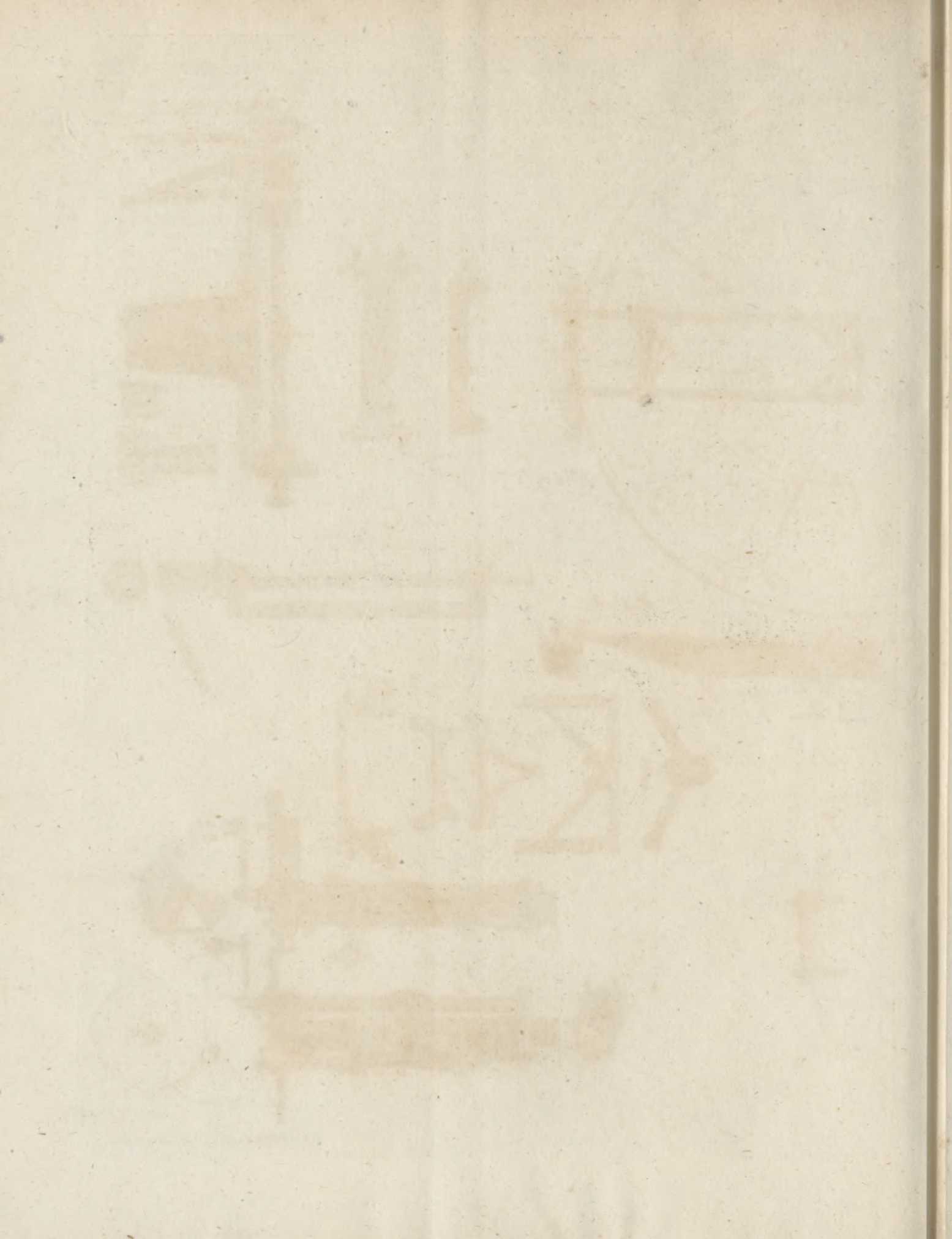


Fig. 8.





Ramus

ties. He published many books, which Teissier enumerates. Ramus's merit in his opposition to Aristotle, and his firmness in undermining his authority, is unquestionably great. But it has been doubted, and with much reason, whether he was equally successful in his attempts after a new logical institute. We have the following general outline of his plan in Dr Enfield's History of Philosophy. "Considering dialectics as the art of deducing conclusions from premises, he endeavours to improve this art, by uniting it with that of rhetoric. Of the several branches of rhetoric, he considers invention and disposition as belonging equally to logic. Making Cicero his chief guide, he divides his treatise on dialectics into two parts, the first of which treats of the invention of arguments, the second of judgments. Arguments he derives not only from what the Aristotelians call middle terms, but from any kind of proposition, which, connected with another, may serve to prove any assertion. Of these he enumerates various kinds. Judgments he divides into axioms, or self-evident propositions, and *dianoza*, or deductions by means of a series of arguments. Both these he divides into various classes; and illustrates the whole by examples from the ancient orators and poets.

"In the logic of Ramus, many things are borrowed from Aristotle, and only appear under new names; and many others are derived from other Grecian sources,

particularly from the dialogues of Plato, and the logic of the Stoics. The author has the merit of turning the art of reasoning from the futile speculations of the schools to forensic and common use; but his plan is defective in confining the whole dialectic art to the single object of disputation, and in omitting many things, which respect the general culture of the understanding and the investigation of truth. Notwithstanding the defects of his system, we cannot, however, subscribe to the severe censure which has been passed upon Ramus by Lord Bacon and others; for much is, we think, due to him for having with so much firmness and perseverance asserted the natural freedom of the human understanding. The logic of Ramus obtained great authority in the schools of Germany, Great Britain, Holland, and France; and long and violent contests arose between his followers and those of the Stagyrice, till his fame vanished before that of Descartes."

RAN, in the old English writers, means open or public robbery, so manifest as not to be denied. *Ran dicitur aperta rapina quæ negari non potest.* Lamb. 125. Leg. Canut. cap. 58. Hence it is now commonly said of one who takes the goods of another injuriously and violently, that he has taken or snatched all he could *rap and ran.*

RANA, or RANULA. See RANULA.

Ran

END OF THE FIFTEENTH VOLUME.

DIRECTIONS FOR PLACING THE PLATES OF Vol. XV.

PART I.			PART II.		
Plate		Page	Plate		Page
CCCXCIV.	} to face	6	CCCCXIV. to face		468
CCCXCV.			CCCCXV.		526
CCCXCVI.			CCCCXVI.		529
CCCXCVII.			CCCCXVII.		562
CCCXCVIII.			CCCCXVIII.		563
CCCXCIX.	}	76	CCCCXIX.	}	584
CCCC.			CCCCXX.		
CCCCI.			CCCCXXI.		
CCCCII.			CCCCXXII.		
CCCCIII.			CCCCXXIII.		
CCCCIV.	}	168	CCCCXXIV.	}	672
CCCCV.			CCCCXXV.		
CCCCVI.			CCCCXXVI.		
CCCCVII.			CCCCXXVII.		
CCCCVIII.			CCCCXXVIII.		
CCCCIX.	}	272	CCCCXXIX.	}	720
CCCCX.			CCCCXXX.		
CCCCXI.			CCCCXXXI.		
CCCCXII.			CCCCXXXII.		
CCCCXIII.			CCCCXXXIII.		
		398	CCCCXXXIV.		798

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